BC Environment

STATUS OF THE GREAT BLUE HERON IN BRITISH COLUMBIA

by
M.B. Gebauer
and
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BIODIVERSITY

Wildlife Working Report No. WR-102

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British Columbia, Canada's most westerly province, has a bounty of biological diversity. British Columbia's snowclad peaks, rain-drenched forests, arid grasslands, all sizes of rivers, lakes, and wetlands, and a long and rugged coast provide habitats for more species of living organisms than are found anywhere else in Canada. However, this very diversity means that there is much to be discovered about these organisms — their distribution, abundance, habitat requirements, and interrelationships with their environment. Increasing our knowledge of this biodiversity will help us with the complex task of sustainably managing our land and waters.

In 1992, the Provincial Government initiated a co-operative biodiversity research program with funding from the Corporate Resource Inventory Initiative, the British Columbia Ministries of Forests (Research Branch), Environment, Lands, and Parks (Wildlife and Habitat Protection Branches), and Tourism and Culture (Royal B.C. Museum), and the Forest Resource Development Agreement (FRDA II).

In 1995, the Ministry of Forests Research Branch and the Ministry of Environment, Lands and Parks developed a biodiversity research and extension strategy, with the assistance of the provincial research community. This strategy was presented to Forest Renewal BC (FRBC), who provided funding for a program beginning in 1995. The goal of the extension component of this program is to extend information to scientists, resource managers, and the public through biodiversity publications. These publications are intended to increase awareness and understanding of biodiversity, promote the concepts and importance of conserving biodiversity, and communicate provincial government initiatives related to biodiversity. We hope that they will be used as tools for the conservation of British Columbia's rich, living legacy.

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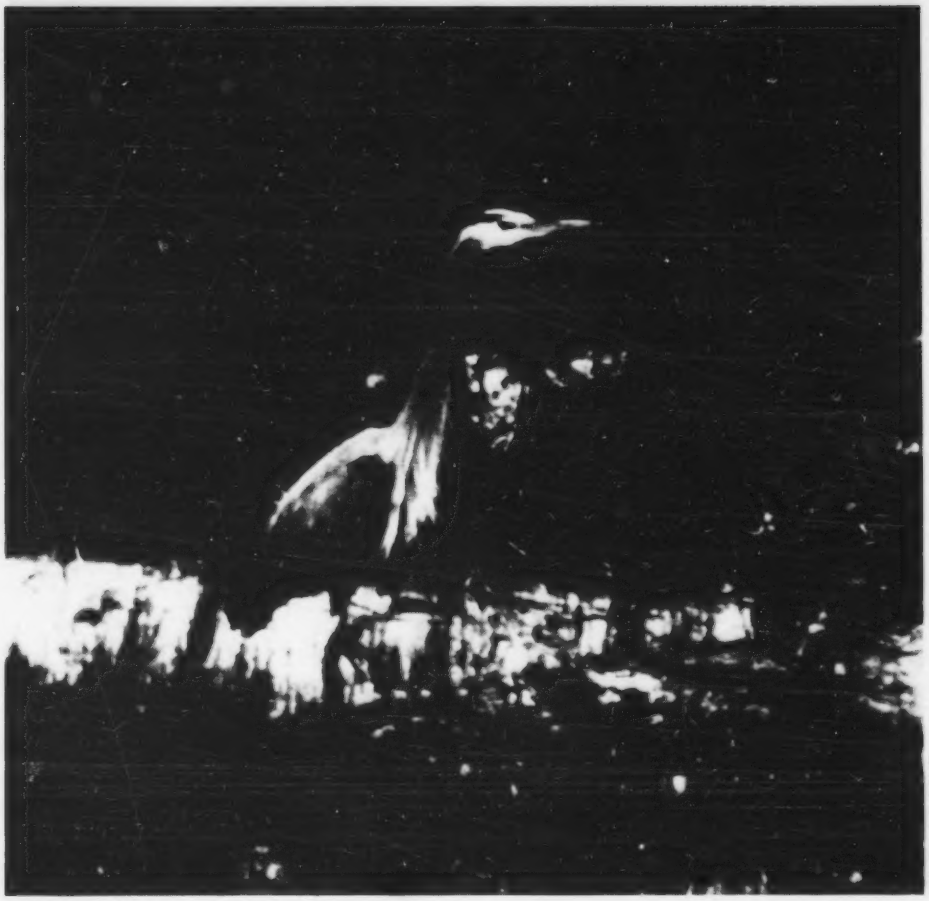

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Great Blue Heron (*Ardea herodias*)

STATUS OF THE GREAT BLUE HERON IN BRITISH COLUMBIA

by
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Ministry of Environment, Lands and Parks
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FOREWORD

The views expressed herein are those of the author and do not necessarily represent those of the B.C. Ministry of Environment, Lands and Parks.

In cases where a Wildlife Working Report or Bulletin is also a species' status report, it may contain a status recommended for the species by the author. This recommended status designation is the opinion of the author and may not necessarily reflect that of the Wildlife Branch. Official status designation will be made by the Wildlife Branch in consultation with experts, and the data contained in the status report will be considered during the evaluation process.

SUMMARY

The Great Blue Heron (*Ardea herodias*) is a large and distinctive wading bird occurring throughout southern British Columbia, but particularly around the Strait of Georgia. Two subspecies are found within the province: *A.h. fannini*, found in coastal areas, and *A.h. herodias*, found in interior areas. Populations on the coast are considered to be stable, although declines have been noted in some regions such as the Sunshine Coast and Powell River areas. Interior populations appear to have increased dramatically since the mid-1900s when only one nesting location was known.

Throughout their range in British Columbia, herons nest in trees. On the coast, the most common tree species used for nesting include red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera*), and Douglas-fir (*Pseudotsuga menziesii*). However, many other species are also utilised, suggesting that the type of tree used is more a function of availability than any particular characteristic of the tree. In the interior, the majority of nests have been found in cottonwoods. Colony-sites are most often located in close proximity to foraging areas in remote areas where human and other disturbances are reduced. Some colony-sites (e.g., Stanley Park) have been established in highly disturbed areas for many years without any apparent impacts to reproductive success, suggesting that in some cases, herons can become habituated to human disturbance. Although many herons nest in large colonies on the coast (e.g., Pacific Spirit Regional Park, ~200 nests; Point Roberts, USA, ~400 nests), others nest singly or in small colonies of fewer than 10 pairs. Most colonies in the interior consist of fewer than 20 breeding pairs.

Foraging areas are one of the primary determinants of colony-site location. Important foraging areas on the coast consist of eelgrass beds, estuarine and freshwater marshes, and upland grasslands. Upland grasslands are particularly important in winter to birds remaining in the Fraser River delta. Townsend's Vole (*Microtis townsendii*) is the primary prey species taken in upland areas, whereas a wide variety of fish, amphibians, and invertebrates are taken in wetland habitats. In the interior of British Columbia, prime foraging areas are along rivers, creeks, sloughs, and lakeshores. Areas of open water in winter are of primary importance to wintering birds.

The Great Blue Heron is currently on the provincial Blue List of Vulnerable species. The *A.h. fannini* subspecies is considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be Vulnerable, whereas the *A.h. herodias* subspecies is considered to be Not At Risk nationally. Although Great Blue Heron breeding populations appear to be stable or declining slightly in coastal areas of British Columbia, an expanding human population, particularly in the Strait of Georgia, is threatening important heron nesting and foraging areas. Increased Bald Eagle (*Haliaeetus leucocephalus*) depredation and contaminants are also potential threats to the population. In the interior, eagle depredation and contaminants are not of as great concern, but increasing human population growth in valley bottoms threaten prime foraging and nesting habitats. Given the vulnerability of existing heron populations in British Columbia to habitat disturbance and destruction, this report recommends that the Great Blue Heron's Blue-List (i.e., Vulnerable) status is maintained for both subspecies.

Primary management needs include ensuring that important foraging areas are protected and that nesting opportunities within three kilometres of foraging areas are provided. Suitable nesting habitats include mature stands of deciduous or coniferous trees relatively isolated from human disturbance. In some areas of the Fraser River delta (e.g., Boundary Bay) forests meeting these criteria have a very limited distribution. On a colony-site basis, management may involve establishment of buffer zones (e.g., 300 m) within which no human disturbance is permitted, barriers to intrusion, and/or seasonal windows within

which human disturbance near colony-sites is minimised. An important research need is the continued monitoring of population size and reproductive success. Although current monitoring has primarily involved the censusing of heron nesting colonies, the program should be expanded to survey herons utilising key foraging areas both during the breeding season and in winter. In most cases, with the exception of some areas of the Fraser River delta, available foraging habitat is likely a more significant limiting factor than the availability of nesting areas.

Stewardship initiatives, such as the Heron Stewardship Program, should be encouraged to facilitate co-operation of private and public landowners. With the exception of some of the well-established larger colonies in the Fraser River delta, many smaller colonies move colony-sites on a regular basis. Protection of small colony-sites through acquisition may not be a wise use of management dollars. Instead, active participation of government personnel, private landowners, and other stakeholders in conservation initiatives will likely be more effective over the long-term.

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1 INTRODUCTION

The Great Blue Heron (*Ardea herodias*) is found throughout North America, Latin America, northern areas of South America, and the Galapagos (Butler 1997). Four subspecies of Great Blue Heron are recognised as occurring within North America;. *A.h. fannini* occurs in the Pacific Northwest and is the most common subspecies in British Columbia; *A.h herodias* occurs throughout continental North America including the southern interior of British Columbia; *A.h occidentalis* is a white form of the Great Blue Heron occurring in the Gulf of Mexico; and *A.h. cognata* occurs only on the Galapagos (Butler 1997). According to an analysis of Breeding Bird Survey data, most heron populations appear to be stable or are increasing (Breeding Bird Survey 1999). The coastal *fannini* subspecies of Great Blue Heron appears to be stable (Fraser et al. 1999) or declining slightly (Moul, unpubl. data), whereas the interior *herodias* subspecies appears to be increasing (Cannings et al. 1987). Primary threats to herons include increasing urbanisation in close proximity to key foraging and nesting areas, Bald Eagle (*Haliaeetus leucocephalus*) depredation, and contaminants.

The purpose of this report is to synthesise information relevant to Great Blue Heron populations occurring within British Columbia, to determine the status of the Great Blue Heron in the province, and to make recommendations to ensure that viable breeding and wintering populations remain in the future. An overview of information on biology, habitat requirements, distribution, limiting factors, and status is provided (gathered from local naturalists, government biologists, published literature, and unpublished reports).

This report is part of an ongoing program of the British Columbia Ministry of Environment, Lands and Parks, Wildlife Branch to more effectively manage species-at-risk for long-term population viability. Funding for this project was provided through the Habitat Conservation Trust Fund.

2 TAXONOMY

The Great Blue Heron has two close relatives: the Cocoi Heron (*Ardea cocoi*), occurring in South America, and the Grey Heron (*A. cinerea*) occurring throughout the Old World. These three species are very similar morphologically, behaviourally, and genetically, suggesting that they may be the same species (Butler 1992a). There are eleven other herons in the genus *Ardea*, most of which occur in the Old World: Great Egret (*A. alba*); Intermediate Egret (*A. intermedia*); Goliath Heron (*A. goliath*); Black-headed Heron (*A. melanocephala*); Humblot's or Madagascar Heron (*A. humbloti*); Cape Verde Purple Heron (*A. bournei*); Purple Heron (*A. purpurea*); White-bellied Heron (*A. insignis*); Pacific or White-necked Heron (*A. pacifica*); Great-billed Heron (*A. sumatrana*); and Pied Heron (*A. picata*) (King and Dickinson 1975; Slater et al. 1986; Jonsson 1993; van Perlo 1995; Bird 1999).

Three subspecies of Great Blue Heron are recognised by Butler (1992a) as occurring within North America (a fourth subspecies is found on the Galapagos off the coast of South America): *A.h. herodias* (most of continental North America); *A.h. fannini* (northwestern North America); and *A.h. occidentalis* (Florida and West Indies). In British Columbia, the *fannini* subspecies occurs along the Pacific coast and occasionally to the Bulkley Valley in the B.C. interior, and the *herodias* subspecies occurs in the southern interior of the province (Cannings 1998).

3 GENERAL BIOLOGY

3.1 Reproductive Capability

3.1.1 Clutch size

Clutch size for the Great Blue Heron ranges from one to eight eggs, with three to five being typical (Ehrlich et al. 1988; Campbell et al. 1990). Campbell et al. (1990) found that 66% of 137 clutches reported in British Columbia contained three to five eggs. Mean clutch size was five eggs in Alberta (Vermeer 1969). Clutch size has been shown to increase with latitude (Pratt 1972; Butler 1992a) and decrease as the breeding season progresses (Pratt and Winkler 1985).

3.1.2 Incubation and fledgling periods

Typical incubation period ranges from 25 to 29 days (Bent 1926; McAloney 1973; Ehrlich et al. 1988; Butler 1992a). Vermeer (1969) found a mean incubation period of 26.7 days for herons nesting in Alberta in 1967. Hatching in heron eggs is asynchronous with the last-laid egg hatching latest, resulting in a size difference amongst chicks (Butler 1991b). The oldest and largest chicks usually get the major share of food brought to the nest and the smallest chicks often starve or are pushed from the nest (Butler 1991b)

Average fledgling period for Great Blue Heron in North America ranges from 56 to 60 days (Ehrlich et al. 1988); however, Vermeer (1969) determined the mean time from hatching to first flight in herons in Alberta to be 52.6 days and McAloney (1973) determined a fledgling age of some broods at Tobacco Island, Nova Scotia to be 45 days. Fledglings become fully independent of their parents about three weeks after their first flight (Butler 1991b).

3.1.3 Timing of reproductive periods

In British Columbia, herons return to nesting colonies on the coast in mid-January and in the interior in late March (Butler et al. 1986; Campbell et al. 1990; Cannings et al. 1997). Nest building is usually initiated in March on the coast and in April in the interior (Campbell et al. 1990). First eggs are usually laid in early April (Butler 1992a). Dates for 137 Great Blue Heron clutches in B.C. ranged from 01 April to 02 July, with most recorded between 16 April and 10 June (Campbell et al. 1990). Dates for 583 broods ranged from 20 April to 31 August, with 55% recorded between 02 and 20 June (Campbell et al. 1990).

3.1.4 Reproductive success

Since annual reproductive success based on the number of nests with eggs is highly variable, most authors report the number of fledged young per successful nest. In southwestern B.C., 15 colonies fledged 2.5 young per successful nest (1977 to 1981), and in the southeast, six colonies fledged 2.7 young per successful nest (1981 to 1983; Forbes et al. 1985b). The number of young fledged per successful nest ranged between 2.18 and 2.70 along the Oregon coast (Werschkul et al. 1977), 2.04 in 1970 in western Oregon (Henny and Bethers 1971), 1.93 young in the San Francisco Bay area (Kelly et al. 1993), and 2.84 on Tobacco Island, Nova Scotia (McAloney 1973). The Stanley Park colony, located in a highly disturbed area, fledged 2.75 chicks per successful nest in 1991 (Otter 1991). Gebauer (1995b) found the mean number of fledged young per successful nest at three colonies on the Sunshine Coast in 1993 to be 2.00, 1.67 and 1.38, which were considerably lower than success rates found by Forbes et al. (1985b) at Sechelt (3.00) and Pender Harbour (3.00) in 1980 and 1979, respectively.

A total of 70% of 583 broods reported in Campbell et al. (1990) had two to three young. Gebauer (1995a) found mean numbers of fledglings per successful nest of 3.38 and 2.62, respectively, at the Nicomekl River and Pacific Spirit Regional Park colonies in 1992. The overall mean number of young per successful nest in the Lower Mainland in 1992 was 2.6. A mean number of 2.67 fledged young per successful nest was determined from the four coastal colonies compared to 1.86 for inland colonies. Vennesland (pers. comm.) found a significant decrease in reproductive success for coastal herons on Vancouver Island and the Sunshine Coast from 1989 to 1999.

3.1.5 Breeding frequency

Great Blue Herons in British Columbia only raise one brood a year (Butler 1997), but may re-nest if they lose their first brood or their nest-site early in the season. Hanrahan (1992) noted that adults at a colony of about 50 nests with chicks at Debouville Slough in Coquitlam, B.C., abandoned the nests because of apparent intensive Bald Eagle depredation and disturbance, but re-nested approximately 500 m away from the original colony-site.

3.1.6 Solitary or colonial breeder

Most Great Blue Herons in British Columbia nest in colonies, with single nests only being reported occasionally (Butler 1997). The reasons why herons nest in colonies is still a mystery, although many authors have hypothesised that mate finding and anti-predator strategies may be factors.

Forbes et al. (1985b) determined that herons in large colonies in Canada reared significantly more young with lower variability in reproductive success than herons in small colonies. Butler et al. (1995) noted that the probability of a pair failing to raise fledged young in a small colony was over 2.5 times greater than in a large colony, but that overall productivity was equal across colony size. Similarly, Gebauer (1995a) found a positive correlation between heron productivity and colony size. In contrast, van Vessem and Draulins (1986) concluded that solitary breeding pairs and newly established colonies of Grey Heron had a higher breeding success than older colonies. These authors suggested that as a colony grows, there might be a gradual occupation of less suitable feeding territories in the area, resulting in a decrease in the overall reproductive success. Butler et al. (1995) noted that the probability of a nest having >3 fledglings was over 12 times greater in a small colony than in a large one.

The number of nests has also been positively related

to the size of nearby foraging areas in British Columbia (Butler 1991a), Oregon (Werschkul et al. 1977; Bayer and McMahon 1981), and Maine (Gibbs 1991; Gibbs et al. 1987). In Maine, Gibbs (1991) concluded that the spatial arrangement of wetlands upon the landscape of inland Maine limited the availability of nesting sites with efficient access to heron foraging areas, and favoured clumped nesting patterns. Werschkul et al. (1977) hypothesised that increased fledgling success in dense colonies was a result of increased efficiency of food gathering through exchange of information within the colony on feeding sites.

3.2 Recruitment

Apparently, most herons first breed in their second spring (i.e., > 22 months)(Pratt 1973). Mortality estimates from band recovery data suggest that 69.0% of the first year birds perish, compared to 36.3% in the second year, and 21.9% in subsequent years (Henny 1972, as cited in Butler 1992). In Spain, Fernandez-Cruz and Campos (1993) estimated the mortality rate of yearling Grey Herons (i.e., <2-year-old) to be 66.7%. An annual recruitment of 1.9 young per breeding pair was estimated by Henny (1972) to be necessary to maintain a stable population, although reproductive success and mortality rates are expected to vary from location to location. Henny's recruitment standard was converted by Forbes et al. (1985b) to 2.4 young per successful nest. Forbes et al. (1985b), recorded a mean of 2.5 fledglings per successful nest in their study in southwestern B.C., and determined that was sufficient to maintain or increase populations.

Powell (1983) determined that food availability limited clutch size and fledgling success in Great White Herons (*A.h occidentalis*). Butler (1994) hypothesised that heron populations not limited by human disturbance or pollution are established largely by the number of immature birds that can acquire the foraging skills necessary to survive their first winter. Fernandez-Cruz and Campos (1993) found that of fledglings produced in a given year, 11.6% returned to the colony the following year, 5.6% after three years, and 3.1% after four years.

3.3 Nest Structure and Composition

Heron nests can range in size from new platforms approximately 50 cm in diameter to older structures approximately 1.0 m across (Butler 1992a). In 1987, at the end of a nesting season, Moul (pers. obs.) ascended a nest tree at the Shoal Island heron colony near Crofton and examined approximately 10 nests. The nests were approximately 30 cm from top to bottom and were slightly concave, with less than a 3 cm depression across a 50 cm diameter. Nests are typically made up of pencil-sized twigs between 20 and 30 cm in length (Butler 1997). The shallow nest cup is often lined with small twigs, bark strips, evergreen boughs, rushes or moss (Butler 1992). Butler (1997) found a range of 2.5 to 4.8 kg for four nests weighed in British Columbia.

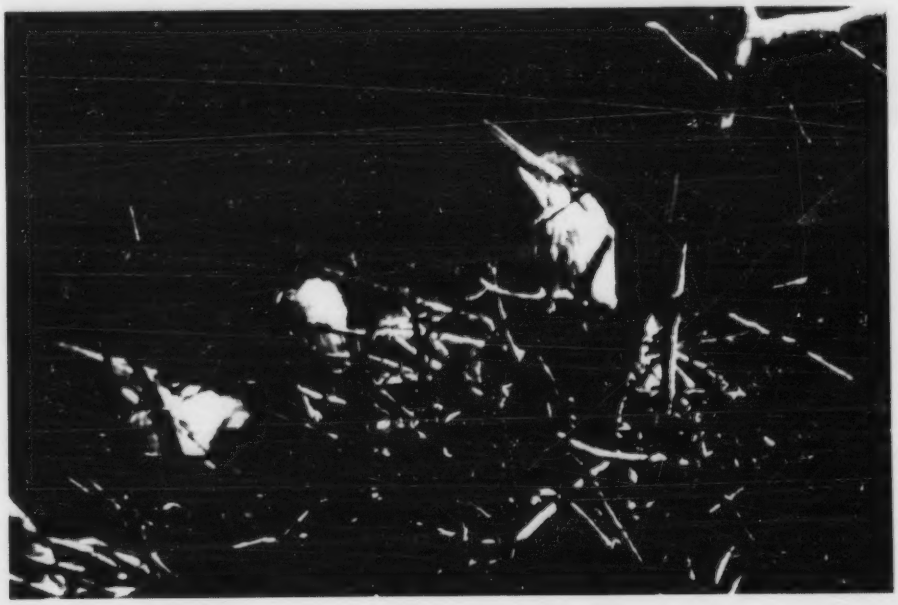

PHOTO: IAN MOUL

PHOTO: IAN MOUL

3.4 Movement Patterns

3.4.1 Seasonal migration

Of the two subspecies of Great Blue Herons in British Columbia, *A.h. fannini* is considered to be mostly resident, with most birds wintering in close proximity to breeding areas (Butler 1997; Fraser et al. 1999), although long-distance dispersal of young has been reported (Campbell et al. (1990) (see Section 3.4.3 below). Campbell et al. (1990) noted that herons congregated in nesting colonies during the breeding season and dispersed throughout coastal areas during the fall and winter months. Butler (1995) observed that during dispersal, adult male herons appear to be more solitary than females and defend a definite feeding territory. Female herons are more often in small congregations. Fledglings and yearlings may be observed with females or alone, often in fields and ditches within a few kilometres of marine areas.

The Great Blue Heron subspecies *A.h. herodias* is found in inland areas of British Columbia and is largely migratory. During the spring and summer breeding season, the herons congregate in breeding colonies. However, as cool weather and freezing conditions approach during the late fall and early winter, most herons migrate south (i.e., southern States and Mexico), with only a few birds remaining around ice-free areas through the winter (Campbell et al. 1990). There are no known studies documenting the migration routes and/or wintering sites of interior herons from British Columbia.

3.4.2 Diurnal movements

During the nesting season, coastal herons feed most actively on the falling tide (Butler 1991a; Moul, pers. obs.). As the ebb tide slackens, herons move back to the colony-sites either to attend nests or to roost in treetops in and around the colony (Butler 1991a). During winter low tides, which are at night, herons may be observed feeding along the shore and in the eel-grass beds (Butler 1991a), similar to observations in Europe for Grey Herons (Draulins and van Vessem 1985). Black and Collopy (1982) found that Great Blue Herons in northern Florida used feeding sites to a greater extent at night. In contrast to activity in coastal marine environments, which is related to tidal movement, nocturnal activity of Great Blue Herons in interior areas such as rivers and lakes may be related to activity patterns of fish (McNeil et al. 1993).

McNeil et al. (1993) found that total diurnal and nocturnal arrivals were more numerous at sunrise and sunset. Daytime activity (i.e., movement) was greater after 14 June, probably because young herons require more and more food as they mature, and activity was greater in nesting pairs with large broods. Herons at both Sidney and Crofton came and went throughout the day and night with no specific differences noted at sunrise or sunset (Moul, pers. obs.). The bulk of daily feedings of chicks was in the hour before and after low tide (high tide having no apparent affect) (Moul, pers. obs.).

Butler (1991a) found that the mean distance between colony sites and principal foraging areas in British Columbia was 2.3 km. Mean distances between colonies and foraging areas ranging from 2.3 to 6.5 km have been estimated by Thompson (1978) and Dowd and Flake (1985) along the upper Mississippi Valley and in South Dakota. Simpson (1984) observed that 78% of herons in the Pender Harbour colony fed in the nearest feeding areas, while the remaining birds chose to travel further to feed. These distant feeders suffered higher nest losses to predators, presumably because they left their nests unattended more often than locally feeding birds.

PHOTO: IAN MOUL

3.4.3 Dispersal of young

Heron chicks leave the nest between eight to ten weeks after hatching (Vermeer 1969). Butler (1995) found that chicks that hatched earlier in the season stayed in their nests significantly longer than chicks hatching later. Upon fledging, chicks move with the adult herons to and from the feeding grounds. Following their first flights, heron chicks return to the nest and are fed by the adults for two to three weeks. There is no evidence that adult herons feed chicks on the feeding grounds or on the forest floor beneath nests. During two years of detailed observation, in only one situation did Moul (pers. obs.) see heron chicks being fed away from a nest. In that situation, a branch had broken, the nest had fallen, and the two surviving chicks were fed on a nearby branch.

Campbell et al. (1972), as cited in Campbell et al. (1990), reported 16 recoveries of young herons banded at the Pacific Spirit Regional Park colony to be widely scattered. Nine were found in the Fraser Lowlands, three were found in Washington State, three were found in the interior of British Columbia as far north as Kamloops, and one was found at Astoria, Oregon.

3.4.4 Colony-site fidelity

Great Blue Herons frequently change their nesting sites (Marquiss 1989). This transient nature of smaller heron colonies in the lower Fraser River valley may be in response to Bald Eagle depredation (Simpson et al. 1987), human disturbance, or other undetermined factors. In the interior of the province, Black Bear (*Ursus americanus*) depredation has been noted at several colonies (R. Packham and D. Peel, MELP, pers. comm.), and may be a factor in the transient nature of herons in this region. Kelsall and Simpson (1979) suggested that the location of heron colonies was far more dynamic than originally thought and that there was considerable interchange between colonies from year to year. Simpson et al. (1987) found nest site and mate fidelity to be low from year to

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year, and suggested that herons may switch colonies readily. Draulins (1988) suggested that heronries probably function as an assembly area for herons to find new mates and nest sites each year.

3.5 Food

Great Blue Herons stalk prey by slowly walking or standing in wait for prey in shallow water, or standing while hunting in upland areas (Butler 1992a). Other aquatic hunting behaviours include, hunting from floating objects, feet-first diving, and diving head first (Forbes 1987b; Butler 1992a; M. Chutter, MELP, pers. comm.). Prey is located by sight, caught by a rapid thrust of neck and head, then generally swallowed whole (Butler 1992a). Main foods taken are discussed in more detail below.

3.5.1 Breeding season

Interior -- Forbes (1987b) found that Great Blue Herons at Creston, B.C., foraged on four introduced fish species including, Largemouth Bass (*Micropterus salmoides*), Yellow Perch (*Perca flavescens*), Black Bullhead (*Ictalurus melas*), and Pumpkinseed (*Lepomis gibbosus*). A number of other fish species, frogs, salamanders, reptiles, aquatic insects, and other wetland prey are likely taken by herons in the B.C. interior.

Great Blue Herons may also forage on upland prey during the breeding season. In Minnesota, Peifer (1979) observed herons foraging on a number of upland species including Thirteen-lined Ground Squirrel (*Spermophilus tridecemlineatus*), Eastern Chipmunk (*Tamias striatus*), Prairie Pocket Gopher (*Geomys bursarius*), Eastern Fox Squirrel (*Sciurus niger*), and Eastern Cottontail (*Sylvilagus floridanus*). Gebauer (pers. obs.) observed a Great Blue Heron capturing a vole on mowed fields at Kelowna International Airport (B.C.).

Grey Herons have been known to prey on adult passerines, including Blackbird (*Turdus merula*; Batty and Forbes 1997), Common Starling (*Sturnus vulgaris*; Bowey 1997; taken in flight), and a swallow (Keighley and Hall 1995; taken in flight). Great Blue Heron depredation of Black Rails (*Laterallus jamaicensis*; Evans and Page 1986), phalaropes (Packard 1943; Merrifield 1992), hatchling Black Terns (*Chlidonias niger*; Chapman and Forbes 1984), and American Dipper (*Cinclus mexicanus*; Parker 1993; taken under water) has also been reported.

Coast -- Prey items include a wide range of insects, fishes, crustaceans, amphibians, reptiles and mammals. Butler (1995) reported the primary food source of coastal breeding herons is fish, consisting primarily of gunnels (46.8%) followed by sculpins (15.1%), and Shiner Perch (*Cymatogaster aggregata*) (10.6%). Based on the energy supplied by the fish, and the handling time required by the herons to catch and swallow the fish, perch are the preferred species followed by gunnels and sculpins. Feeding solely on perch during the time of their greatest abundance (May and June), a heron could meet its daily energy requirement in slightly more than two hours. In contrast, a heron consuming only gunnels would require the entire low tide just to maintain its own energy requirement. Fish and crustacean prey species of Great Blue Heron reported by Forbes and Simpson (1982) in Pender Harbour (as reported in Verbeek and Butler 1989) and Butler (1995) at Sidney Island included Pacific Staghorn Sculpin (*Leptocottus armatus*), Tidepool Sculpin (*Oligocottus maculosus*), Arrow Goby (*Celvelandia ios*), marine worms (*Nereis limnicola* and *N. brandti*), Blue Mud Shrimp (*Upogebia pugetensis*), Red Ghost Shrimp (*Callianassa californiensis*), Threespine Stickleback (*Gasterosteus aculateus*), Saddleback Gunnel (*Pholis ornata*), Starry Flounder (*Platichthys stellatus*), Shiner Perch, Chum Salmon fry (*Oncorhycnchus keta*), Bay Pipefish (*Syngnathus griseolineatus*), and Plainfin Midshipman (*Porichthys notatus*).

Herons in the Lower Mainland region are often observed feeding in upland areas on Townsend's Voles (*Microtis townsendii*), particularly in early and mid-winter. These observations emphasise the opportunistic foraging habits of Great Blue Herons. Significant impacts of herons on commercial fish farms have also been reported (Parkhurst et al. 1987; Parkhurst et al. 1992; Stickley et al. 1995). Great Blue Herons have also been observed catching goldfish from garden ponds, and fish-farms and hatchery operators in British Columbia have reported herons catching juvenile trout and salmon (Butler 1991b).

Peifer (1979) observed a heron capturing a young Eastern Cottontail in Minnesota. Some foraging on Lower Mainland populations of young Eastern Cottontail by herons may also be occurring. Feunteun and Marion (1994) found the diet of Grey Herons to be varied at a large colony in France, consisting primarily of fish but also grass snakes, voles, rats (*Rattus norvegicus*), insects, and shrimp (*Palaemonetes varians*). Although fish represented only 44% of the prey taken in the study, they made up 88% of the mass.

3.5.2 Non-breeding season

Interior -- Little is known of the feeding habitats of Great Blue Herons in the B.C. interior during the winter, but fish are presumably the most important prey taken. Winter observations indicate that non-migrating birds congregate around ice-free watercourses. Herons have been reported fighting each other to death for access to open water foraging sites in the ice (Forbes and McMackin 1984).

Coast -- Following the breeding season, in August, September and October, herons in the Fraser River delta consumed primarily perch (63.1%) and sculpins (30%) (Butler 1995). As the fall progressed into winter, herons shifted to a mixed diet of fish and, especially during stormy weather, the Townsend's Vole (*Microtus townsendii*) (Butler 1995). Less is known about winter food sources in coastal marshes.

3.6 Causes of Mortality

3.6.1 Egg Mortality

Common Ravens (*Corvus corax*) were often present in a colony at Pender Harbour, B.C., where they were observed taking eggs from unprotected nests (Simpson and Kelsall 1978). Ravens were seen regularly at Sidney Island, making daily forays to the colony, and up to 35 depredated eggs were located below the colony (Butler 1989). Egg scavenging by Common Ravens has also been noted by Gebauer (1995a and 1995b) and Moul (1990), particularly when herons were disturbed and left eggs unguarded. Vennesland (pers. comm.) observed Bald Eagle attacks on eggs at seven of 24 colonies, both in 1998 and 1999. A colony at Harrison Lake was abandoned in 1998 when eagles attacked nests just after egg-laying commenced.

Nest depredation by Red Fox (*Vulpes vulpes*) has been reported by Kelly et al. (1993) in the San Francisco area, and by crows on Tobacco Island, Nova Scotia (McAloney 1973). Crows and Raccoons (*Procyon lotor*) are also likely predators of eggs in British Columbia.

3.6.2 Chick Mortality

Bald Eagles are significant predators of Great Blue Herons, particularly of the vulnerable unfledged chicks. In the Strait of Georgia colonies, Norman et al. (1989) observed approximately one Bald Eagle incursion for every 10 hours of observation, whereas Vennesland (pers. comm.) observed one incursion for every four hours, an apparently large increase in Bald Eagle depredation of heron colonies in the region. On Vancouver Island, Bald Eagles have been observed preying directly upon chicks in colonies at Victoria (Beacon Hill, Government House, and Tillicum), Sooke, Maple Bay, Duncan (Quamichan Lake and Drinkwater Road), Crofton, Nanaimo (Holden Lake and Hammond Bay), Nanoose (Beachcomber and North-west Bay), Denman Island (North-west, North-end and Denman Point) and Hornby Island (Landing and Tralee 1, 2 and 3) (Moul 1998a). Gebauer (1995a) observed intensive Bald Eagle activity at a colony at Debouville Slough, Coquitlam in May 1992. On one occasion, an eagle was observed in the colony for 40 minutes, during which it attacked chicks in three nests. At another colony site at Harrison Lake, 21 heron carcasses (mostly chicks) were found below the colony, suggesting that intensive Bald Eagle depredation had occurred. Bald Eagle depredation was also noted in other coastal colonies at Halfmoon Bay (Redroofs Bay), Gibsons (Stewart Road), Pacific Spirit Regional Park, Point Roberts, Powell River (Glacier Street) and in Richmond (Gebauer 1995a and 1995b). Vennesland (pers. comm.) observed eagle attacks in 14 of 24 Strait of Georgia colonies studied in 1998 and 1999, and had reports from landowners of attacks at five of the 24 other colonies (i.e., ~80% of colonies). Simpson and Kelsall (1978) observed that eagles nesting in a large fir overlooking the Pender Harbour colony on the Sechelt Peninsula appeared to use the young chicks as a convenient food supply. Bald Eagles have also been reported depredating nests in the Williams Lake area in the B.C. interior (D. Peel, MELP, pers. comm.).

Kelly et al. (1993) reported young herons being pulled from the nest by ravens in the absence of adult herons, and being eaten on the ground. Chick depredation by Golden Eagles (*Aquila chrysaetos*), Great Horned Owls (*Bubo virginianus*), Red-tailed Hawks (*Buteo jamaicensis*), and Raccoons has also been reported (Lopinot 1951; Pratt 1972; Kelsall and Simpson 1979; Hjertaas 1982; Pratt and Winkler 1985; Forbes et al. 1985b; Simpson et al. 1987; Burkholder and Smith 1991; Kelsall 1992). Several authors have noted that disturbance by humans or eagles facilitated raven or crow depredation (Taylor and Michael 1971; Simpson and Kelsall 1978; Simpson 1984; Quinney 1983; Drapeau et al. 1984; Moul 1990). Packham (MELP, pers. comm.) noted that a colony at Exeter Lake near 100 Mile House, B.C., had been subjected to Black Bear depredation. Black Bear depredation has also been noted at the Swanson Road

and Big Lake colonies in the Williams Lake area (D. Peel, MELP, pers. comm.). In 1999, Vennesland (pers. comm.) witnessed an unsuccessful attack of a Cooper's Hawk on chicks at the Pacific Spirit Regional Park colony.

Young chicks have been reported being pushed out of their nests or killed by older and larger siblings (Mock 1985; Sullivan and Payne 1988; Burkholder and Smith 1991; Butler 1997; Vennesland, pers. comm.). McAloney (1973), Collazo (1981), Quinney (1982), Pratt and Winkler (1985), Powell and Powell (1986), and Sullivan and Payne (1988) considered the main cause of nestling mortality to be starvation of youngest nestlings, primarily because of their failure to compete successfully with older siblings for food. Ninety percent of the Great Blue Heron nestlings that died on Tobacco Island, Nova Scotia, were last-to-hatch birds. Owen (1960), as cited in Forbes et al. (1985b), found nestling mortality to be as high as 46% in the Grey Heron in Europe, stating that it was always the smallest, last-hatched young that died. Breault (1990) collected 130 chick carcasses from below heron colonies in the Strait of Georgia. Trauma from falling from nests was the primary cause of death.

In Ohio, Burkholder and Smith (1991) found that the most important cause of nestling mortality was weather-related. Severe storms blew nestlings and entire nests containing nestlings out of trees. Owen (1960), as cited in Forbes et al. (1985b), found that nestling mortality in Grey Herons in Europe was inversely correlated with the quantity of rainfall. The higher mortality rates were either caused by lower foraging success of adults due to increased turbidity and rippling of the water surface, or to nestlings succumbing to hypothermia brought on by the rain. Severe winter weather has been reported to cause local population declines in Great Blue Herons in the Columbia Basin (Blus and Henny 1981).

Other causes of chick mortality have included fish bone obstruction of the esophagus, and nest structures falling from trees (Collazo 1981).

3.6.3 Adult Mortality

Evidence of three adult heron kills, apparently by Bald Eagles, was found at the Pender Harbour colony near Sechelt, B.C., (Simpson and Kelsall 1978). Aquarium staff reported an adult heron being taken by an eagle at the Stanley Park colony (Vennesland, pers. comm.). On Cape Breton Island, a Bald Eagle was recently observed (02 August 1999) chasing an adult-sized heron over the water, where it proceeded to swoop at it and eventually kill it (D. Banks, Eagle-Net, UBC, 1999).

Adult herons have been known to die from attempting to swallow prey that is too large (Wolf and Jones 1989). Two heron carcasses and one live heron were found entangled in monofilament line hanging from several black cottonwoods (*Populus balsamifera*) near the Mary Hill Bypass, Port Coquitlam colony (Gebauer 1995a). Bird entanglements were recognised by Parnell et al. (1988) as being a frequent human-caused accident.

Winter starvation may also be factor in adult Great Blue Heron mortality. Wilson et al. (1995) listed 22 case histories representing 32 heron mortalities examined between January 1970 and December 1993. Of these mortalities: cause was undetermined in 17 cases, trauma was cited in 10 cases, two suffered mercury poisoning, one died from suspected pesticide poisoning, one from bacterial infection, and one died of starvation.

3.7 Sensitivity to Human Disturbance

Most heron colonies are extremely sensitive to human disturbance, particularly during the early stages of nest selection, nest building, pair formation and egg-laying (Quinney 1983; Butler 1992a; Vos et al. 1985). Once eggs are laid, adults flush reluctantly, and once chicks are in the nest few adults will flush. As the chicks grow, there appears to be a growing commitment by the adult herons and they are much less likely to abandon a nest when disturbed. Vos et al. (1985) determined that the distance in which herons responded to experimental human intrusion averaged around 150 m early in the breeding season, dropping to 60 m late in the breeding period. Vennesland (pers. comm.) found that herons at isolated colonies in southwestern British Columbia reacted more strongly to human disturbance than at colonies in urban settings, and that response varied as the season advanced. Herons at the isolated Canadian Forces Base and Hatzic colonies reacted strongly to the approach of Vennesland at 100 m and 90 m, respectively, whereas urban colonies at Beacon Hill Park, Victoria, and Stanley Park, Vancouver, never responded. At nine colonies in southwestern British Columbia, Vennesland (pers. comm.) found that the average distance at which herons responded to the first approach of a colony in the season was 49 m, whereas response distance to the last approach averaged 15 m, suggesting that herons habituate to observers over the season.

Heron colony abandonment as a result of human disturbance has been widely documented (Werschkul et al. 1976; Kelsall and Simpson 1979; Forbes et al. 1985b; Mueller and Glass 1988). Forbes et al. (1985a) found

that 17 of 27 colony abandonments occurred as a result of some human activity near the colony-site, such as tree-felling, flooding, off-road vehicles and activity by researchers. Simpson (1984) found that construction work on a housing development resulted in adult herons leaving active nests more often, with a consequent heavy loss of young to Bald Eagle depredation. Urban development has been cited as the primary cause of abandonment in herons (Forbes et al. 1985a; Kelsall 1992). Simpson and Kelsall (1978) found that construction of a housing development adjacent to a Pender Harbour colony near Sechelt, B.C., during the summer of 1978 resulted in abandonment of approximately 73% of the nests. Vennesland (pers. comm.) documented humans as being responsible for only one of 14 colony-wide abandonments, compared to seven of 14 for eagles.

Nest and colony abandonments increase with increased visits by humans (Drapeau et al. 1984) and with road building and logging activity within 0.5 km (Werschkul et al. 1976). In Quebec, Drapeau et al. (1984) found that in 1979, when human disturbance of a heron colony was frequent, only six of the 17 nests produced fledglings with the other 11 being deserted at the onset of breeding activities. This was compared to 1980 when human disturbance was minimal and only one of 14 active nests was abandoned. On average, 2.86 and 3.07 young herons, respectively, were produced per active and successful nest in 1980 as compared to 0.88 and 2.5 in 1979. In Ohio, disturbance by human foot traffic resulted in significantly fewer chicks fledged per nest per heronry than sites with either no disturbance or mechanical disturbance (i.e., farm equipment, vehicle traffic, trains, and low-flying aircraft) (Carlson and McLean 1996). Klein (1993) concluded that humans approaching waterbirds on foot was the most disruptive of the usual activities of refuge visitors in southwestern Florida. Herons appeared to habituate more easily to mechanical disturbances (Carlson and McLean 1996). Watts and Bradshaw (1994) found that Great Blue Herons nesting in the lower Chesapeake Bay area located their colonies away from man-made structures. Potential adverse effects of human disturbance on productivity include overheating or cooling of temporarily deserted eggs or young, breakage of eggs, young being accidentally pushed from the nest or frightened and caused to leave the nest prematurely, and increased depredation by gulls and corvids (Vos et al. 1985).

Several studies have provided evidence that some heron colonies can become habituated to non-threatening human disturbance (Anderson 1978; Parker 1980, as cited in Butler 1992a; Webb and Forbes 1982; Vos et al. 1985; Gebauer 1995a). In British Columbia, a colony at Stanley Park is located in a highly disturbed area (Otter 1991) but has reproduced successfully in most years (i.e., 1977-1997), and another colony was established in a cedar hedge between a busy parking lot and an access road to Vancouver International Airport between 1981 and 1992 (Webb and Forbes 1982). Butler (1991b) described established colony sites in highly disturbed areas at an industrial site near Parksville, and in Beacon Hill and Cuthbert Holmes Parks in Victoria, and one pair raised young in a nest in a tree along a suburban street in Vancouver.

If dense vegetation obscures human activity, herons appear less likely to react. At the Canadian Forces Base colony, Gebauer (1995a) speculated that a natural 50 m buffer of cottonwoods on one side and a 5 m wide dugout waterway between the colony and dike on the other side, may have contributed to a colony's lack of response to activities. A 100 m cottonwood buffer may have sheltered a colony by the Mary Hill Bypass, Port Coquitlam. Bowman and Siderius (1985) and Vos et al. (1985) also suggested that a dense buffer of trees or shrubs might reduce the impact of potential disturbances.

3.8 Sensitivity to Depredation

Great Blue Herons appear to be very sensitive to depredation. In British Columbia, herons, their eggs, and their chicks have been preyed upon by Bald Eagles, Common Ravens, Northwestern Crows (*Corvus caurinus*), Raccoons , Black Bears (i.e., Williams Lake area, J. Steciw, MELP. pers. comm.), and in one situation, likely an Opossum (*Didelphus virginianus*) (Breault 1990; Moul 1990; R. Packham and D. Peel, MELP, pers. comm.). Since the late 1980s, there has been a steady increase in the numbers of reports about herons being preyed upon by Bald Eagles (Norman et al. 1989; Moul 1990, 1991, 1992, 1993, 1994, 1995, 1998a, 1998b, 1999a, 1999b; Gebauer 1995a and 1995b). During the 1997, 1998 and 1999 nesting seasons, all colony abandonments in the Georgia Depression Ecoprovince could be linked at least in part to depredation by eagles (Moul 1998a, 1998b, 1999a and 1999b; Moul, pers. obs.; Vennesland, pers. obs.). Eagles were documented as being involved in seven of 14 colony abandonments in southwestern British Columbia in 1998 and 1999, and anecdotal evidence suggests that they were also involved in the abandonment of the other seven colonies. Vennesland (pers. comm.) found that the proportion of initiated colonies that were abandoned completely

in the Strait of Georgia was significantly higher ($p = 0.001$) in the period 1997-99 (36%) compared to 1989-92 (15%).

Bald Eagles are significant predators of Great Blue Herons, particularly vulnerable unfledged chicks. Gebauer (1993) observed intensive Bald Eagle activity at a colony at Debouville Slough, Coquitlam in May 1992. On one occasion, an eagle was observed in the colony for 40 minutes during which it attacked chicks in three nests. At another Lower Mainland colony site (Harrison Lake) in 1992, 21 heron carcasses (some of which were adults) were found below the colony, suggesting that either intensive Bald Eagle depredation or human disturbance (i.e., shooting) had occurred. Bald Eagle depredation was also noted in colonies at Halfmoon Bay (Redroofs Bay), Gibsons (Stewart Road), Pacific Spirit Regional Park, Point Roberts, Powell River (Glacier Street) and in Richmond (Gebauer 1995a and 1995b). Herons abandoned a colony-site on Sidney Island in the Strait of Georgia after Bald Eagles preyed on chicks and adults (Butler 1995).

Several studies have linked Bald Eagle disturbance and depredation to heronry abandonment or lowered reproductive success (Vermeer 1973; Kelsall and Simpson 1979; Forbes 1987a; Norman et al. 1989; Hanrahan 1992). Breault (1988) suggested that smaller colonies were more likely to be abandoned under severe Bald Eagle depredation than larger colonies. Depredation by eagles and other predators appears to be highest, relative to total number of nests, in small colonies (Butler et al. 1995). Gebauer (1995a) found that nesting success of herons was negatively correlated ($r=-0.89$; $p<0.01$) to the intensity of depredation by Bald Eagles and corvids. There is some concern that increasing Bald Eagle populations on the west coast of Canada (Vermeer et al. 1989; Blood and Anweiler 1994; Gebauer 1994) are resulting in increased depredation of heron colonies. Increasing Bald Eagle populations are likely due to improved conservation and protection measures and a ban on harmful pesticides such as DDT.

A survey by Gebauer (1995a) noted that Common Ravens commonly raided nests, taking eggs. Egg depredation increased dramatically when the colony was disturbed by the presence of humans. Other authors have also noted that disturbance by humans or eagles facilitate raven and/or crow depredation (Taylor and Michael 1971; Simpson and Kelsall 1978; Quinney 1983; Drapeau et al. 1984; Simpson 1984). In British Columbia, Great Horned Owls have caused abandonment of colonies at Cowichan Bay Village and Crescent Beach (Kelsall and Simpson 1979; Forbes et al. 1985a). At other colonies, nesting Great Horned Owls do not appear to have affected reproductive success of herons (Gebauer 1995a; M. Chutter, MELP, pers. comm.).

Despite heavy Bald Eagle depredation in some areas, Butler (1991b) demonstrated that the distribution of heron colony sites was unrelated to the density of breeding eagles. Herons did not appear to avoid nesting in areas where eagles nested in high densities.

At the Stanley Park colony, Otter (1991) found the number of fledged chicks/nest in six nests in the lower part of the tree to be 3.17 compared to 2.3 for six nests in the upper portion of the tree. The author hypothesised that the difference in survival may be related to reduced depredation in the lower portions of the tree. All three occurrences of Bald Eagles at the colony were of birds landing in the upper branches of the tree. Vennesland (pers. comm.) found that
the height of the nest in the tree crown was not significantly related to nest productivity at the Pacific Spirit Regional Park and Point Roberts colonies (only sites with data); however, nests at the edge of colonies were more likely to abandon.

3.9 Adaptability to Sudden Environmental Change

Herons appear to have a fairly high tolerance to "sudden" environmental change, given that they have persisted in the local area for some 9000 years, since the last ice age (Hobson and Driver 1989). Global climate change may result in changes to marine productivity, which may influence foraging opportunities for herons; however, very little work has been conducted in this area. Sea level rise resulting from climate change may squeeze herons into already greatly reduced habitats and will eliminate others entirely.

Severe winter weather has been reported as causing local population declines in Great Blue Herons in the Columbia Basin (Blus and Henny 1981). In Ohio, Burkholder and Smith (1991) found that the most important cause of nestling mortality was weather-related. Severe storms blew nestlings and entire nests containing nestlings out of trees. Dying trees were also a natural cause of disturbance to herons in Ohio. In Florida, Powell and Powell (1986) concluded that harsh weather could be a significant source of heron nestling mortality, either directly from exposure or indirectly through the depression of food accessibility.

Table 1. Size comparison of maximum numbers of active nests at Great Blue Heron colonies in four areas of British Columbia.

Area of Province	Sample size (colonies)	Mean number of nests	Standard deviation	Range
Vancouver Island	73	21.7	25.8	2 - 131
Lower Fraser Valley	49	49.0	77.4	2 - 472
Sunshine Coast and Powell River	17	22.7	24.4	2 - 97
Interior British Columbia	25	23.2	27.1	3 - 122

4 HABITAT

4.1 Habitat Description

Great Blue Heron habitat consists of breeding areas (section 4.1.1), feeding habitat associated with either the nesting season (section 4.1.2) or the non-breeding season (section 4.1.3), and roosting sites (section 4.1.4). It is reasonable to assume that the quality of the foraging habitat has a strong influence on the location of the breeding sites.

4.1.1 Breeding

Interior -- Interior Great Blue Herons nest in colonies along the margins of lakes, slow-moving rivers, sloughs, or marshy lakes and wetlands (Campbell et al. 1990). Vermeer (1969) found that all heron colonies in Alberta in 1967 were situated near water, with most located on lake islands.

Very little has been documented about nesting requirements for interior herons in British Columbia. In the southern interior of British Columbia, black cottonwood was the most commonly used nesting tree (Butler 1991b), whereas in the central interior (e.g., Williams Lake area), all nests were in coniferous trees including, lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), and Douglas-fir (*Pseudotsuga menziesii*)(J. Steciw, MELP, Williams Lake, pers. comm.). Most nests along the Columbia River in south-eastern B.C. have been located in black cottonwood (R. Fergusen, pers. comm.). In north-western Montana, of 220 nest trees containing 578 nests, 88% of the nests were in black cottonwood, 9% were in ponderosa pine (*Pinus ponderosa*), 2% in lodgepole pine and 1% in spruce (Parker 1980).

Colony size, averaged from a sample set of the maximum number of active nests recorded in colonies of two nests or greater (Appendices 1, 2 and 4), differs very little in size between Vancouver Island, the Sunshine Coast/Powell River, and colonies in the interior (x = 22-23 nests; Table 1). Colonies in the lower Fraser Valley (including Point Roberts) were, on average, over twice the size as those in the rest of the province (x = 49 nests; Table 1). In comparison, Gibbs and Kinkel (1997) reported that 28 known colonies in Illinois averaged 159 nests (range 5 to 550, SD 180), significantly larger than those in British Columbia. The authors' data suggest some possible factors (e.g., food availability, lack of depredation etc.) that are resulting in the larger colonies.

Coast -- Great Blue Heron breeding habitat in coastal areas of North America consists of forested locations in close proximity to wetland feeding areas (Thompson 1982; Butler 1997; Gibbs and Kinkel 1997). Butler (1991a) measured an average flight distance of 2.3 km (SD = 1.3) between feeding grounds and nest sites at 22 colonies. Butler (1991a) further determined that twenty-nine of 33 colony-sites were located within six kilometres of their main feeding site.

Colonies may be in coniferous, deciduous, or mixed species forests. Vermeer (1969) and Gray et al. (1980) noted that nests tended to be at the tops of taller trees in a forest stand, perhaps in response to ground predators, greater visibility, and flight access. The most common nest trees on the B.C. coast are red alder and black cottonwood (Butler 1991b; Gebauer 1995a). A survey by Gebauer (1995a) in 1992 in the lower Fraser River valley located 787 active nests (from 13 colonies) in eight tree species. The majority were in red alder (48%) and black cottonwood (30%) with fewer in bigleaf maple (*Acer macrophyllum*; 8%), Sitka spruce (9%), Douglas-fir (2%), white birch (*Betula papyrifera*; 1%), western hemlock (*Tsuga heterophylla*; 1%) and western redcedar (*Thuja plicata*; <1%). Of the four coastal colonies in the study, 85% nested in red alder. In the eight inland colonies (i.e., Fraser River valley), 74% of the nests were in cottonwood.

Of 104 alders measured by Moul (unpubl. data) for diameter at breast height (DBH) the average was 35 cm

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and the smallest was 22 cm. Of a sample size of 68 Douglas-firs used for nesting, the average DBH was 45 cm, with the smallest being 17 cm. The minimum age class of both alder and fir would be approximately 25 years. At the McFadden Creek colony on Saltspring Island, when given a choice of nest trees consisting of bigleaf maple, black cottonwood, Douglas-fir, red alder and trembling aspen (*Populus tremuloides*), herons chose aspen for 57 out of the 118 nests (Moul 1998a). Black cottonwood was second with 24 nests, maple was third with 19 nests, alder was fourth with 13 nests, and five nests were in Douglas-fir. At another colony site at Little River near Courtenay, where nests were in a mixed stand of aspen, alder and Sitka spruce, 42 nests were in aspen, two in spruce and none in the alder (Moul 1992). To the best of our knowledge, there have been no measurements of canopy closure at heron colonies.

Although Great Blue Herons in other parts of North America have been reported to nest on the ground or on artificial structures, this has apparently not been observed in British Columbia. The degree of forestation, presence of hardwoods, and distance of an island from towns and other islands with colonies were apparently important factors in selection of nesting islands by Great Blue Heron in Maine (Gibbs et al. 1987). In addition, Gibbs (1991) found that Great Blue Heron colonies in Maine were closer to local concentrations of foraging than expected by chance.

4.1.2 Summer foraging

Interior -- Interior foraging habitat for the Great Blue Heron is primarily lakeshores, marshes, ponds, sloughs, slow moving rivers, and wetlands (Campbell et al. 1990; Butler 1992a).

Coast -- Great Blue Herons frequent a variety of freshwater and saltwater environments including, sheltered and shallow bays, lagoons, inlets, coves, tidal mudflats, sloughs, marshes, rivers, and irrigation ditches (Campbell et al. 1990). In the Fraser River delta, heron foraging habitat during the breeding season is primarily along beaches and in extensive eelgrass beds (e.g., Boundary Bay, Robert's Bank) in close proximity to breeding colonies (Butler 1991a). Butler (1991a) noted a positive correlation between colony size and the abundance of prey within the feeding areas.

4.1.3 Non-breeding foraging

Interior -- Great Blue Herons forage along areas of open, ice-free water such as creeks and the shorelines of lakes where an adequate food source (i.e., fish) is available. Herons have also been observed feeding on voles in grassy areas (e.g., Kelowna Airport runway edges) during the nonbreeding season (Gebauer, pers. obs.).

Coast -- Following dispersal from the breeding areas, coastal herons in the Lower Mainland area are frequently observed feeding in ditches, old fields, and in marshes and wetlands (Butler 1997). In October and November, adults moved to marshlands and juveniles moved to old-field habitats when they could no longer maintain daily energy balance on beaches as a result of declining duration of low tides and food intake rates (Butler 1991a). Butler (1995) suggests that the movement to inland foraging areas is in part a response to late fall tidal cycles which reduce the time intertidal areas are exposed. In February and March, when the tide cycle becomes longer and tides are lower, there is a trend away from old fields and marshlands and back towards the tidal areas. Both the greater availability of foraging time and an influx of fish into the near-shore waters may trigger the onset of the breeding season. In Scotland, Grey Heron feeding rates were highest around low tide, and no feeding took place three hours before and after low tide (Richner 1986).

Old field-habitats in the Fraser River delta are primarily used in winter for hunting a favoured prey species, the abundant Townsend's Voles (*Microtis townsendii*) (Taitt and Krebs 1983). The use of pasture and old fields by Great Blue Herons appears to be much more limited on southern Vancouver Island (Moul 1992). This is likely due to the absence of abundant small mammal prey such as the Townsend's Vole, which is plentiful in the Lower Mainland (McTaggart-Cowan and Guiguet 1965).

4.1.4 Roosting

Interior -- Roost sites of interior herons have not been well documented. Likely roost sites are in coniferous trees in close proximity to summer colony-sites or winter foraging areas. Herons have been observed roosting on ice along the edge of open water during the winter (Gebauer, pers. obs.).

Coast -- Herons may be observed individually or in groups perched on trees, jetties, pilings, wharves or rocks, throughout the year (Campbell et al. 1990). During the breeding season, when not feeding, herons will often return to the nesting colonies to either perch on the nest (when chicks are young) or in the tree tops overlooking the nesting colony. Outside of the breeding season, herons often congregate to roost in trees near the feeding grounds, often selecting sunny exposures out of the wind (Butler 1991b).

Butler (1992b) described roost sites of herons in Mud Bay and on the Tsawwassen Indian Reserve that held over 100 birds each in August, most birds roosted alone or in flocks of <20 birds on beaches and on farm fields. A greater proportion of juveniles roosted on farm fields than adults.

4.1.5 Staging

Very little data on staging areas (i.e., used for resting and foraging during migration) for Great Blue Herons in

PHOTO: IAN MOUL

British Columbia were found. Butler (1997) noted that Tofino Mudflats support up to 100 herons in August of each year, but that few stay during the breeding season. Important staging areas are likely large estuaries on the coast, and large wetland complexes, such as Okanagan Lake and Shuswap Lake in the interior.

4.2 Habitat Distribution

4.2.1 Interior

Important foraging areas for herons in the interior of British Columbia are generally in valley bottoms, where the most extensive wetland complexes are located. Some of the most important areas, both during the breeding and wintering season, are: the Columbia River between Golden and Columbia Lake (~26,000 ha; R. Fergusen, pers. comm.); the lowland areas in the Nelson and Castlegar areas; the Okanagan Valley, Nicola Lake and associated wetlands; Shuswap Lake and the upper Thompson River system between Salmon Arm, Savona and Clearwater; and the wetlands of the Cariboo/Chilcotin (Campbell et al. 1990; Fraser et al. 1999).

4.2.2 Coast

Herons are distributed along the entire B.C. coast wherever suitable foraging habitats are available. Breeding has been documented primarily around the Strait of Georgia, but smaller colonies and non-breeding birds have been observed along the North Coast, west coast of Vancouver Island, and in the Queen Charlotte Islands. Habitats of highest value to herons include the Fraser River delta, the lower Fraser River valley, southern Vancouver Island, the Gulf Islands, and the east coast of Vancouver Island. Although extensive foraging habitats exist in the Tofino area and other areas of the outer coast, few nesting sites have been reported from these regions.

4.3 Trend in Quality and Quantity of Critical Habitat

For Great Blue Herons, critical habitat constitutes feeding, breeding, roosting, and staging areas.

4.3.1 Interior

Throughout the southern interior of British Columbia, there is constant development pressure for lands, particularly flat lands near water, which are best suited to nesting and feeding herons. While lands are constantly being secured and even rehabilitated for the benefit of wildlife, increasing human populations are an ongoing threat to heron habitat needs.

4.3.2 Coast

In coastal areas, especially in the Fraser River delta and on southeastern Vancouver Island, development pressure is particularly strong. These coastal areas are in high demand because of their proximity to large urban centres, marine areas, and mild climate. Nesting areas are in constant threat of reduced quality and quantity, and the trend is for increased development. Fisheries regulations confer some protection against development of foraging areas along the foreshore and particularly within eel-grass beds, but disturbance to foraging herons still results from increased traffic by boaters, fisherman, pedestrians and dogs, and from industrial development. While there is no evidence of reduced quantity of habitat, a detailed inventory has not been completed. The risk of destruction of marine feeding habitat through industrial accidents remains an ever-present threat.

4.4 Present Habitat Status

4.4.1 Interior

Very little work has been conducted in the interior to survey heron populations or to assess the status of their habitat. Several colony-sites have protection (e.g., Vaseux Lake; Wilmer Wildlife Area), but many others remain unprotected. For the most part, it appears that sufficient suitable nesting and foraging habitat exists for Great Blue Herons in the interior.

4.4.2 Coast

Between 1996 and 1999, much work has been done to catalogue and protect coastal nesting areas. A joint heron stewardship project initiated between Environment Canada, the B.C. Ministry of Environment, Lands and Parks, and the Wild Bird Trust in 1996, had the goal of securing protective status for 1200 heron nests in the lower Fraser Valley and Vancouver Island. Through November of 1999, including Point Roberts, 974 nests or 81% of the goal had been achieved (P. Baudin, Wild Bird Trust, pers. comm.). The bulk of this effort was centred on the larger colonies of greater than 50 nests. Current and ongoing efforts will focus on smaller sites.

5 DISTRIBUTION

5.1 North America

5.1.1 Breeding season

The breeding range of the Great Blue Heron extends from southeastern Alaska east to the Gaspé Peninsula and Nova Scotia and south to northwestern and northeastern Mexico, the West Indies, and the Galapagos Islands, with several breeding colonies known from the Yucatan Peninsula in Belize and Mexico (Godfrey 1986; Butler 1992a; Howell and Webb 1995) (see Figure 1).

5.1.2 Non-Breeding season

The Great Blue Heron winters from southern British Columbia and the northern United States, south to Panama, Columbia and Venezuela, with stragglers occasionally reported from the Hawaiian Islands (Butler 1992a; Howell and Webb 1995) (see Figure 1).

5.2 British Columbia

In British Columbia, Great Blue Herons breed along the coast, and along river valleys and wetlands in the southern interior (Figure 2). Most coastal breeders are found in the Georgia Depression (Fraser et al. 1999), though there are some breeding records from the Queen Charlotte Islands and from Prince Rupert (Campbell et al. 1990). Breeding occurs in the southern interior from the Okanagan Valley to as far north as Williams Lake, as well as in the west Kootenays to as far north as Golden (Fraser et al. 1999). Coastal wintering birds congregate mostly on the Fraser River delta, while most of those that remain in the interior do so in the Okanagan Valley. (Fraser et al. 1999; Campbell et al. 1990).

5.2.1 Breeding season

Interior -- Great Blue Herons breed in the Columbia River valley and other areas of the south Kootenay, in the Okanagan Valley, at Nicola Lake near Merrit, along

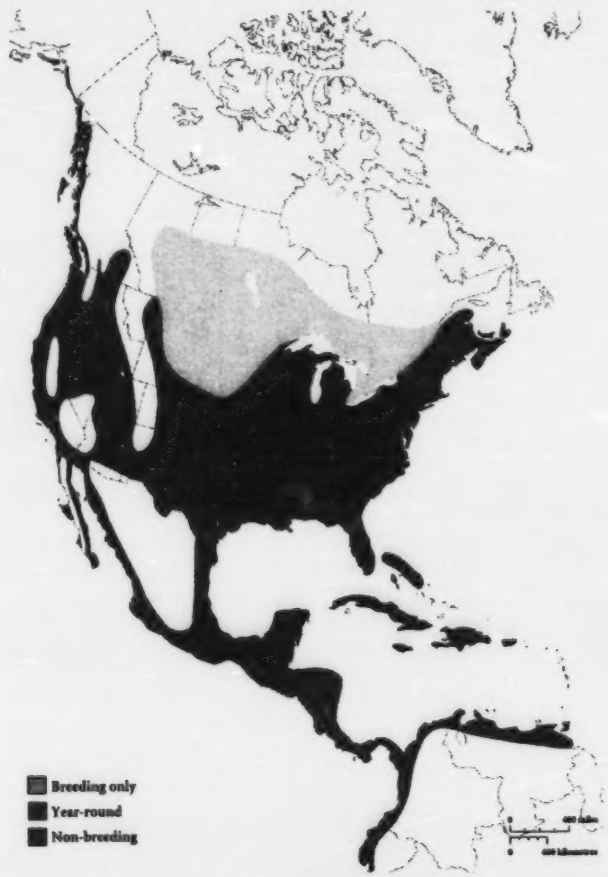

Figure 1. Breeding and non-breeding distribution of the Great Blue Heron in North America (Butler 1992a).

Shuswap Lake, along the Thompson and North Thompson Rivers, and in the Cariboo/Chilcotin area (Fraser et al. 1999; see Figure 3 and Appendix 4).

Coast -- Primary breeding areas are around the lower Fraser River valley (Figure 4), with examples of larger colonies being Point Roberts, Washington (~400 active nests), Pacific Spirit Park (174 active nests), Alouette River (120 active nests) CFB Chilliwack (114 active nests), and Mary Hill Bypass (107 active nests). Colonies are also located in the southern Gulf Islands and on the eastern coast of Vancouver Island (Figures 5 and 6) where larger ones include: McFadden Creek on Saltspring Island (131 nests); Drinkwater Road in Duncan (71 nests); Tralee Point on Hornby Island (50 nests); Beacon Hill Park in Victoria (48 nests); and Holden Lake, Nanaimo (43 nests) (see Figure 4).

Smaller breeding colonies have also been reported from Tahsis on the west coast of Vancouver Island (Butler 1997), in the Port Alberni area of central Vancouver Island (Forbes et al. 1985a), and from the Queen Charlotte Islands (Forbes et al. 1985a; A. Hetherington, MELP, pers. comm.; Figure 7). A complete list of known coastal colonies is provided in Appendices 1, 2 and 3.

5.2.2 Non-breeding season

Interior -- The primary wintering area of Great Blue Herons is in the Okanagan Valley (Campbell et al. 1990), particularly along some of the larger lakes that do not freeze over in most years. High Christmas Bird Counts have been reported at Vernon (29 birds; 18 December 1983), Vaseux Lake (18; 23 December 1981), Kelowna (18; 20 December 1981), and Oliver/Osoyoos (18; 28 December 1981)(Campbell et al. 1990). Smaller wintering numbers have been reported from the Kootenay region including, Nakusp (1), Lake Windermere (5), and Revelstoke (3)(Campbell et al. 1990).

Coast -- The largest wintering populations of Great Blue Herons on the coast are found in the Fraser River delta (Campbell et al. 1990). Campbell et al. (1990) reported high Christmas Bird Counts of 251 and 248 from Ladner (27 December 1981) and Vancouver (18 December 1977), respectively. Large congregations of wintering herons have also been reported from southern Vancouver Island at Victoria (152; 15 December 1984). Smaller wintering populations occur on the North Coast and in the Queen Charlotte Islands. High CBC counts of 11, 24, 40, were reported in Campbell et al. (1990) along

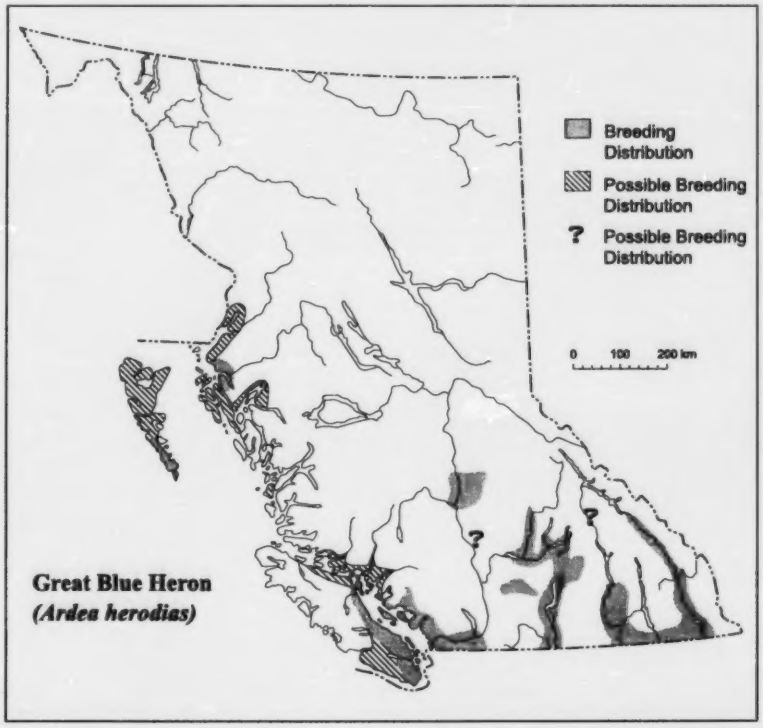

Figure 2. Current breeding distribution of the Great Blue Heron in British Columbia (Fraser et al. 1999).

the North Coast at Bella Bella, Deep Bay, and Prince Rupert, respectively (between the mid 70s and mid 80s), along with high counts of 15 herons at both Masset and Skidegate Inlet (between 1982-84).

5.2.3 Staging

Staging areas for Great Blue Herons in the interior are likely along the larger lakes and watercourses (e.g., Okanagan Lake). On the coast, large estuaries such as the Fraser River delta, Sidney Island, Tofino Mudflats, and mudflats at Comox are likely important staging areas.

6 POPULATION SIZE AND TRENDS

6.1 Population Size

Determination of the true population size is extremely difficult and problematic. Most recorded efforts of systematic counts have focused on nest numbers in breeding colonies. If colonies were easy to locate and remained in locations for periods of years, they would likely be an excellent measure of the population size and trends. Unfortunately, herons abandon colonies and move frequently, and a constant search effort is required to locate new colonies. Counts of herons on the feeding grounds, during both the breeding and non-breeding seasons, may represent a more consistent measure of the population. To date, no ongoing effort has been made to document numbers of feeding herons in British Columbia.

6.1.1 Historical

Interior -- Brooks and Swarth (1925) considered the Great Blue Heron to be a "scarce visitant to the Okanagan Valley, becoming more numerous of recent years", and also reported that no breeding records existed for the region to 1925. Based on documented occurrences in Munro and Cowan (1947) and Cannings et al. (1987), current populations are much larger than those of the early 1900s.

Coast -- Very little data prior to the past 30 years are available for herons nesting in coastal areas. Heron population size within the last 30 years is discussed under Section 6.1.2 below.

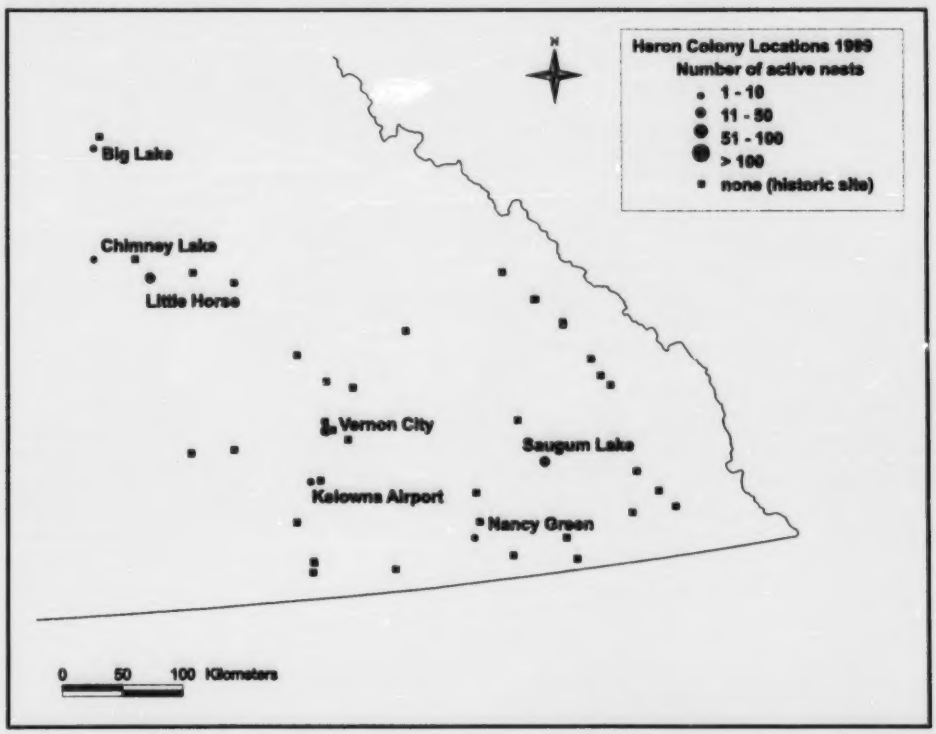

Figure 3. Location of Great Blue Heron (*A.h. herodias*) colonies in the interior of British Columbia.

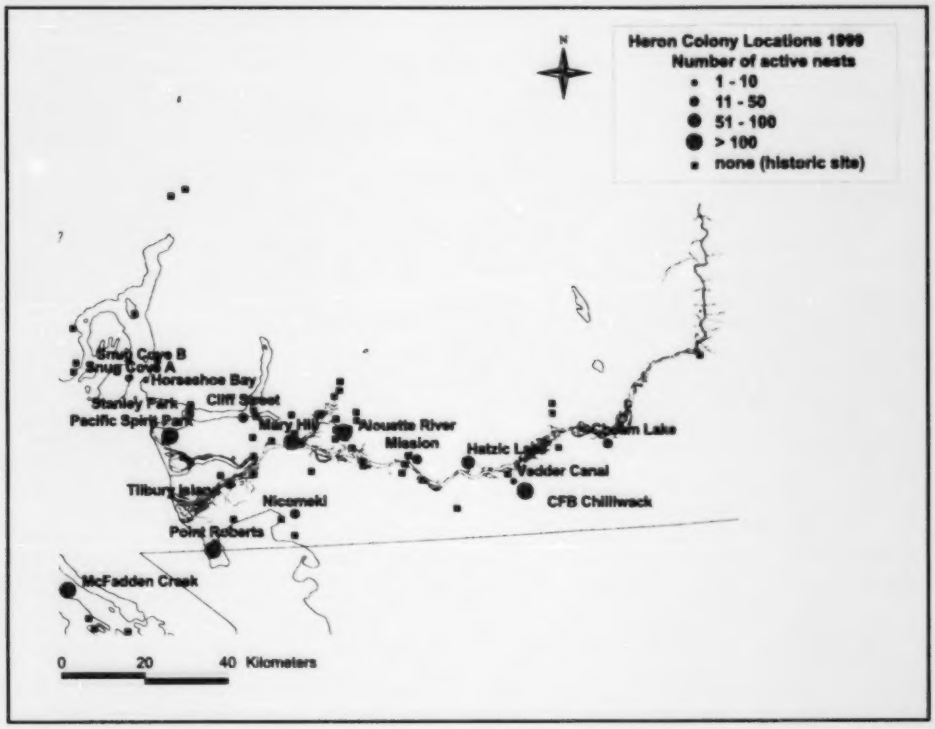

Figure 4. Location of Great Blue Heron (*A.h. fannini*) colonies in the Lower Fraser River Valley, British Columbia.

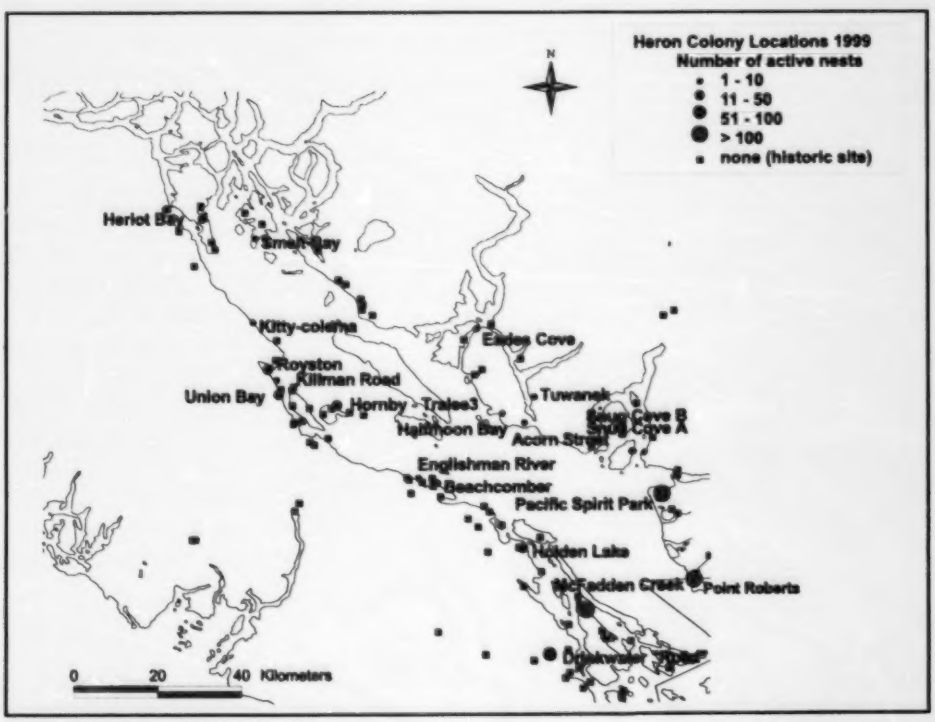

Figure 5. Location of Great Blue Heron (*A.h. fannini*) colonies on east central Vancouver Island and the Sunshine Coast, British Columbia.

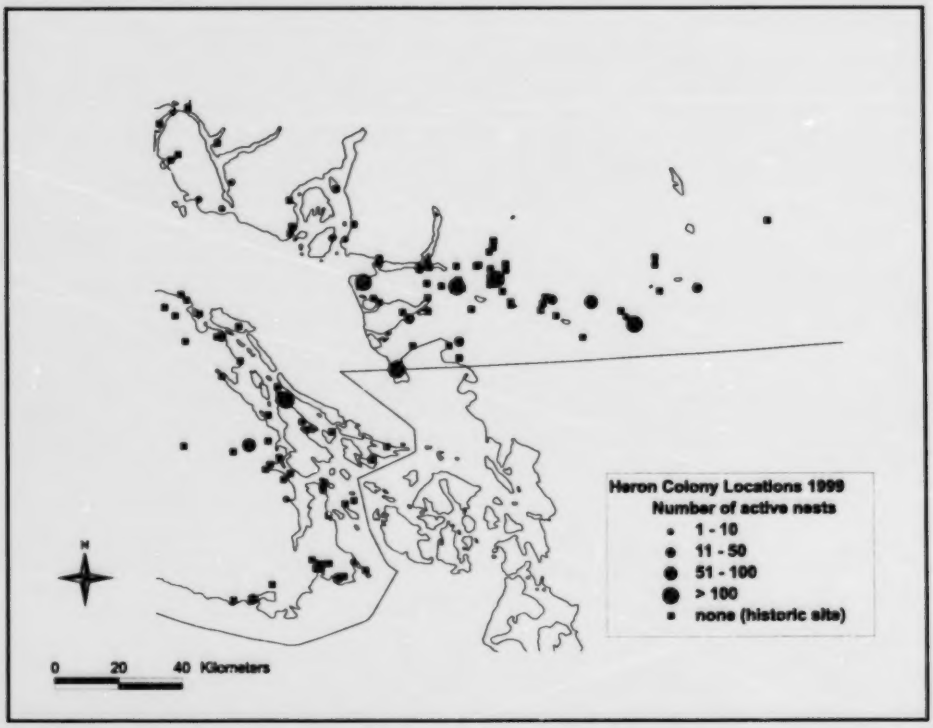

Figure 6. Location of Great Blue Heron (*A.h. fannini*) colonies on southeast Vancouver Island, British Columbia.

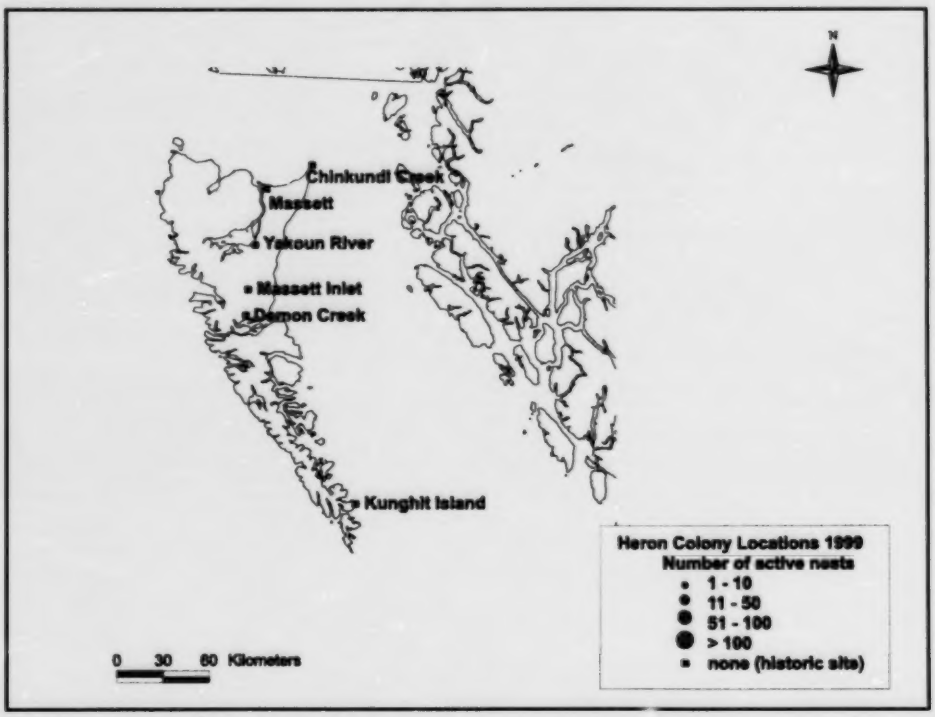

Figure 7. Location of Great Blue Heron (*A.h. fannini*) colonies on the north coast of British Columbia and on the Queen Charlotte Islands.

6.1.2 Current

Interior -- Interior Great Blue Heron populations are very difficult to estimate but, based on existing literature and records collated in Appendix 4, likely range between 300 and 700 birds. A total of 47 nesting locations have been reported since 1941, with the largest colony at Duck Lake, Creston, reporting a maximum of 122 nests in 1975 (Forbes et al. 1985a). Thirteen colonies have consisted of more than 20 nests (Appendix 4). Christmas Bird Count data on herons counted in the interior is discussed in section 6.2.2.

Coast -- Estimating the number of herons in the Strait of Georgia is also very difficult. Butler (1997) acknowledged problems with the data set when he made the first estimate of the number of herons in the Strait of Georgia. Historical records were often collected for purposes such as toxicity tests on eggs collected and estimates of reproductive success, and do not lend themselves readily to extrapolation for estimating populations. An unknown number of colonies were undoubtedly overlooked, including some that had over 50 pairs. Double-counting nesting pairs likely occurred, since birds abandoning colonies are known to re-nest, though it is unknown what proportion will make multiple attempts.

Butler's (1997) estimate of 2076 breeding pairs (4152 breeding adults) for the Strait of Georgia area of British Columbia included 387 pairs from the Point Roberts, USA colony. The Point Roberts colony was included in this tally because the majority of these birds forage in British Columbia, and it is therefore functionally part of the Fraser River delta ecosystem. His estimate was extrapolated from nest count data from several reports presented in Butler (1995) and Gebauer (1995a; cited as Gebauer 1993). The data presented in Butler (1995) was the sum of the maximum number of TOTAL nests/colony/year counted in 21 Vancouver Island colonies and 3 Lower Mainland colonies between 1987 and 1992. The results in Gebauer (1995a) represented the sum of the number of ACTIVE nests counted in the Lower Fraser valley in 1992. Unaware that Gebauer had included the Fraser River delta in his total for the Lower Fraser valley, Butler (1997) erroneously double-counted 413 active nests (235 from Point Roberts, 142 from UBC sand 36 from Nicomekl) in his total. This error means that the estimated 2076 pairs reported in Butler (1997) was high, and should have been 1663 (2076 minus 413) nesting pairs. Furthermore, the net result of 1663 nesting pairs may still be high as it is in part made up of counts of TOTAL nests (not necessarily active nests), and also does not take into account the possibility double-counting herons which may have moved between colonies during the 1987 to 1992 period.

Using counts of ACTIVE nests in 1999, Moul (2000a and b) presents a Strait of Georgia population estimate of 1537 breeding pairs of herons (Table 2), which is close to Butler's (1997) corrected total of 1663.

Butler (1997) estimated a further 300 breeding pairs of *A.h. fannini* for other coastal areas of B.C. outside of the Strait of Georgia, which would have resulted in an overall BC population estimate of close to 2400 pairs, or 4800 breeding adults. Revising this number using the corrected Strait of Georgia estimate would reduce the B.C. population estimate to just under 2000 breeding pairs. The historical data have been recompiled following a protocol to establish a common usage of historical data (Moul et al. 2000). Therefore, though a definitive conclusion on the population change of coastal herons can not be made, it is estimated that the coastal (*fannini*) heron population ranges between 3000 and 6000 birds and has not changed significantly since Butler's (1997) estimate.

6.2 Population Trends

6.2.1 Interior

Brooks and Swarth (1925) considered the Great Blue Heron to be a "scarce visitant to the Okanagan Valley, becoming more numerous of recent years", and also reported that no breeding records existed for the region. Munro and Cowan (1947) considered herons in the Okanagan to represent post-breeding dispersal of young possibly from known colonies in Washington State. The only known nesting sites prior to 1947 in the interior were at Gardom Lake near Enderby in 1945 and 1946 (Munro and Cowan 1947) and Columbia Lake near Fairmont in 1941 (Forbes et al. 1985a). Since that time, an increasing number of heron nesting locations have been reported. Forbes et al. (1985a) reported 23 new colony sites in interior B.C., while Cannings et al. (1987) reported five additional colony locations in the Okanagan alone. The authors were able to find records for 17 more interior colonies during research for this report. Appendix 4 lists all 47 currently known breeding sites. It is apparent that heron breeding populations are increasing in interior areas of the province (Campbell et al. 1990; Canning et al. 1987).

6.2.2 Coast

Known records found by the authors of nesting Great Blue Herons on the north coast, central coast and Queen Charlotte Islands are limited to ten nests in six sites in the Queen Charlotte Islands (Appendix 3). However, Campbell et al. (1990) state that isolated pairs also breed near Prince Rupert. For herons nesting around the Strait of Georgia, there are five data sets available for attempting to draw trends in heron populations: total numbers of nests; numbers of active nests; numbers of successful nests; Christmas Bird Counts; and Breeding Bird Surveys.

Total numbers of nests

The total numbers of nests represent counts completed in the winter when herons are away from the colony sites. As heron nests may persist after being abandoned for many years, this data set is not considered of use in measuring population trends.

Numbers of active nests

With much of the historic data, there has been little differentiation between total numbers of nests and those that were active in a given year (Appendix 1 and 2). In many records, if no distinction was made, but the colony was known to have been active, the number of active nests was recorded as equal with the total nest count (Moul et al. 2000). For the *fannini* subspecies, between 1970 and 1999, the number of nests known to be active has increased from 385 to 1537 nests (Table 2; Figure 8). This result must be examined very carefully, however, as there has been no method to balance the known numbers of active nests with the search effort to derive the value. It could be assumed that increasing and cumulative survey effort resulted in an awareness of more colonies and more known active nests. Prior to 1988, there was no attempt made to find all colonies, so it is not surprising that fewer nests were recorded in the earlier years. In years such as 1976 (70 active nests) and 1985 (1 active nest), it must be assumed that herons were in fact nesting and the low numbers reflected a very low census effort. While it may be difficult to document a declining trend in nesting herons over a large area based on a fluctuating search effort, a decline in known active nest numbers in a specific area may be an important indicator. Along the Sunshine Coast and in the Powell River area, ongoing and punctuated search efforts (i.e., 1995 to 1999) have not revealed new colony locations or a sustained number of existing colonies (Vennesland, pers. comm.; Moul, pers. obs.). In 1970, there were no records of active heron colonies. In 1978, during a research project and an intensive search effort, Forbes et al. (1985b) located 97 active nests along the Sunshine Coast (Table 2). Between 1988 and 1993, intensive search efforts produced a maximum combined annual total of 82 active nests in 1993: 59 on the Sunshine Coast and 23 in the Powell River area (Breault 1990; Moul 1993; Gebauer 1995). A punctuated search

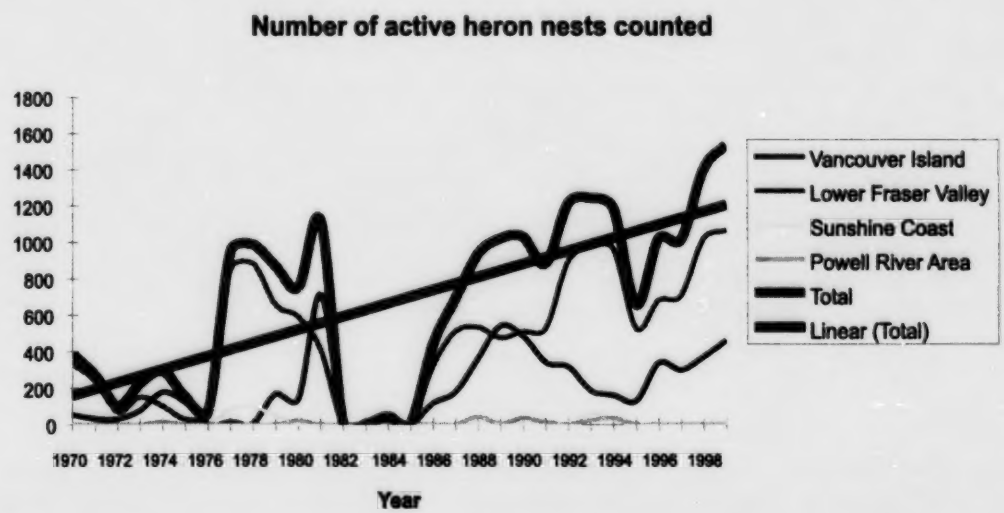

Figure 8. Numbers of active Great Blue Heron nests counted in various regions around the Strait of Georgia, British Columbia, 1970 through 1999.

Table 2. Numbers of active Great Blue Heron nests counted in four areas around the Strait of Georgia, British Columbia, 1970 to 1999.

Year	Number of active nests counted				
	Vancouver Island	Lower Fraser Valley	Sunshine Coast	Powell River area	Total
1970	54	331	0	0	385
1971	32	240	0	0	272
1972	30	71	0	0	101
1973	76	149	0	0	225
1974	176	101	0	14	291
1975	121	28	0	0	149
1976	0	70	0	0	70
1977	14	849	85	0	948
1978	7	882	97	0	986
1979	167	653	45	0	865
1980	138	591	2	19	750
1981	212	406	0	0	618
1982	1	0	0	0	1
1983	1	0	0	0	1
1984	42	1	0	0	43
1985	1	0	0	0	1
1986	116	321	0	0	437
1987	178	509	0	0	687
1988	361	532	0	42	935
1989	540	476	0	4	1020
1990	484	510	0	35	1029
1991	341	528	0	13	882
1992	315	894	5	0	1214
1993	186	976	59	23	1244
1994	161	961	31	34	1187
1995	130	526	0	0	656
1996	337	681	0	0	1018
1997	299	708	6	0	1013
1998	370	1019	10	0	1399
1999	460	1065	12	0	1537

effort between 1997 and 1999 has produced a total of 12 active nests in the Sunshine Coast and none in the Powell River area (Moul 1999b; Vennesland 2000). On the Sunshine Coast, in the 23 years from 1977 to 1999, there has been an overall decline in both active nest numbers and in the size of the various colonies (Table 2). The mean size of heron colonies found in the Sunshine Coast and Powell Rivers in 1992 and 1994 was ten active nests, with a maximum of 20 active nests at one colony, Scuttle Bay, in 1994 (Gebauer 1995). Forbes et al. (1985b) described large colonies in the late 1970s. In 1977, the colony at Gunboat Bay, Pender Harbour had 75 active nests and in 1978 a colony at Twin Creeks, in Gibsons Landing had 54 active nests. Possible explanations for the decline include, increasing Bald Eagle depredation, rapid urban encroachment and increased human disturbance.

Measurements of nest success

In contrast to the numbers of heron nests known to be active, measurements of nest success, in known sample sizes, across the same time period have declined (Figure 9). In the 1970s, it was common to document successful nesting attempts (i.e., at least one fledgling per nest) at most nests in a colony. For example: in 1971, 67 successful nests out of 67 active nests at Marine Drive near UBC and 68 successful nests out of 68 active nests at Nature Park in Port Coquitlam (Forbes et al. 1985a). As of 1998 and 1999, it has been increasingly common to observe repeated much lower success rates. In 1999, for example, 7 of 48 nests were successful in Beacon Hill Park, 0 of 10 in View Royal, 15 of 30 at Nicomekl, and 106 of 174 at Pacific Spirit Park, UBC (Moul 2000a and 2000b; Vennesland 2000). Once again, it must be pointed out that this result may be problematic as there is no way to quantify the survey effort. Nest success records collected during recent heron colony surveys have typically been made during five visits to a colony, with three of the visits timed bi-weekly to correspond to post-hatching weeks 5, 7 and 9 (Moul et al. 2000). During research projects colony visits may increase to multiple visits each week. Assuming that increased visits to a colony will not adversely effect nesting success by the disturbance factor, increased visits will most likely result in an increased detection of short duration failed nesting attempts. There appears to be no way to establish an effort factor for historic records.

Christmas Bird Counts

In comparison to the above measures of active nests and successful nests, Christmas Bird Count (CBC) data has the advantage of being collected away from colony sites, at specific points, (circles), year after year. Another advantage of CBC data, is the clear record of search effort, defined as the number of observers and the time taken to make observations (party-hour). To account for years where circles were not censused: 1) the authors eliminated data from circles missed more than once between 1991 and 1997; and 2) a missing value was derived by taking the average of the years were censuses were made. For records that were recorded as a negative number, to indicate the sighting was made outside the census time period, (six instances of one heron counted during counts in the interior of the province), the absolute value was used.

The resulting data set was portrayed in two ways: as total numbers of herons counted (Figure 10), and as the ratio of herons counted over the search effort (party-hour) (Figure 11). Each of the two portrayals of the data produced a different result. For example, with herons counted in the Lower Fraser Valley, the total numbers counted increased from 1991 to 1997, while the herons counted per party-hour declined slightly. With the Sunshine Coast, herons per party-hour declined quite sharply, while the total number of birds counted declined only slightly. It was only on counts in the north coast and Queen Charlotte Islands that herons per party-hour showed an

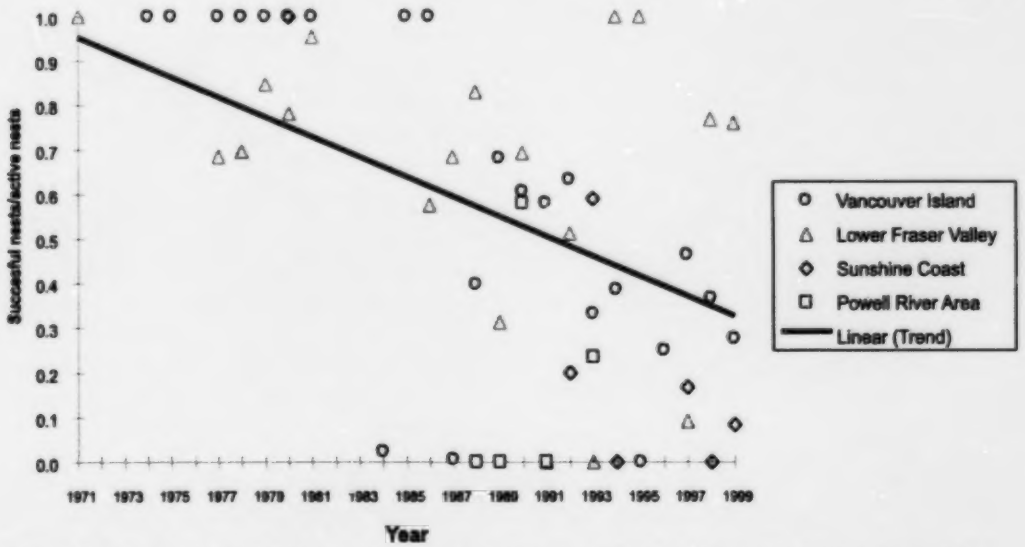

Figure 9. Nest success at Great Blue Heron colonies around the Strait of Georgia, British Columbia, between 1971 and 1999.

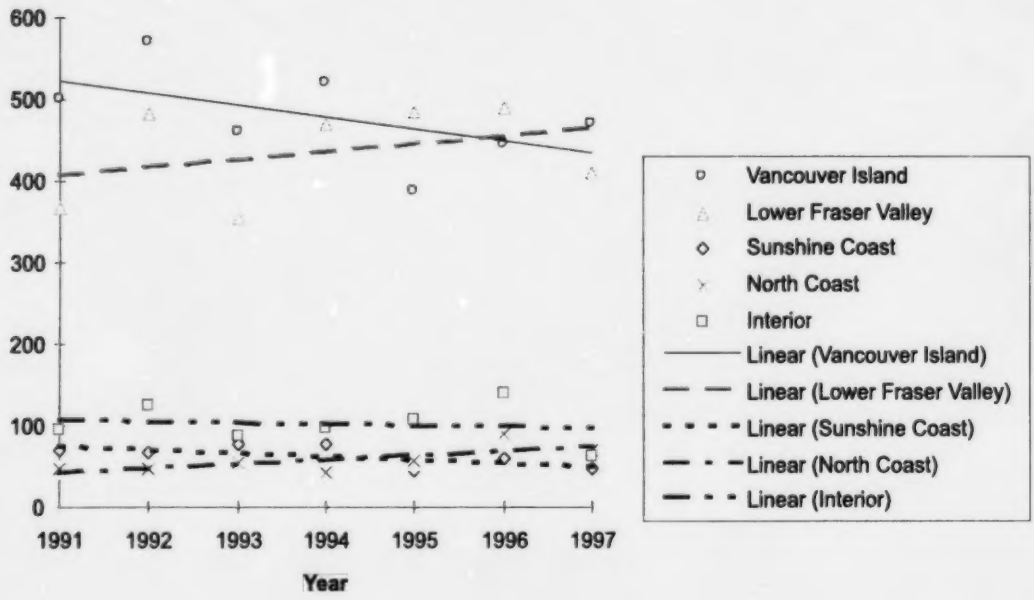

Figure 10. Total numbers of Great Blue Herons counted during Christmas Bird Counts, in British Columbia, 1991 through 1997.

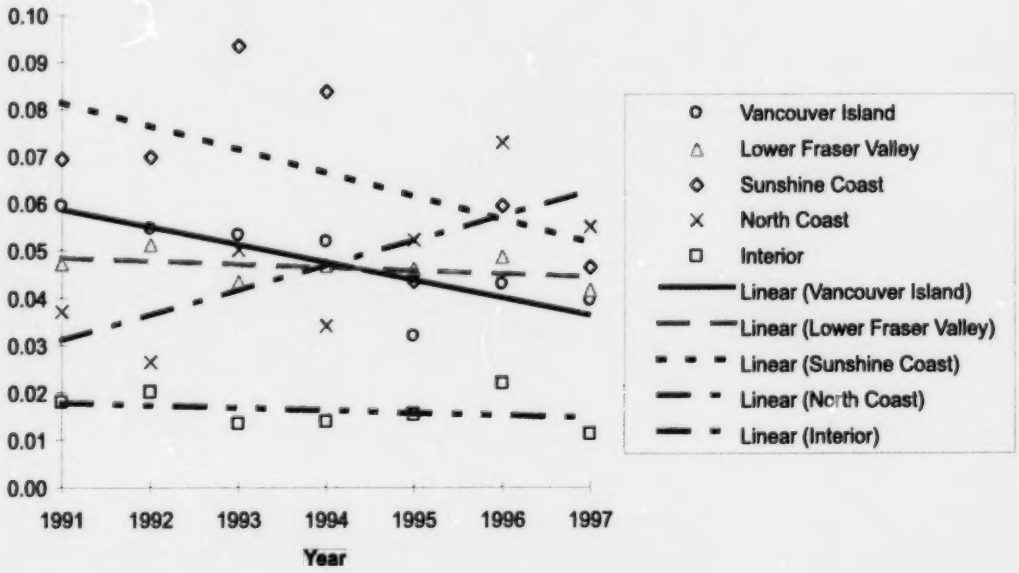

Figure 11. Numbers of Great Blue Herons counted per search effort (party-hour) during Christmas Bird Counts, in British Columbia, between 1991 and 1997.

increase (quite sharp), paired with a slight increase in the total numbers of herons counted. When attempting to draw a conclusion regarding trends in heron populations using CBC data, the authors suggest that the total numbers of herons counted is a more accurate and useful result. As herons are large conspicuous birds, and the Christmas Bird Counts are conducted in the winter when obscuring foliage is minimal, we suggest that very few herons would be missed and the effects of high search effort would skew the data towards a lower number of herons counted per party-hour. Overall, the CBC data suggest a stable population of Great Blue Herons in both the interior of the province (ssp. *herodias*) and on the coast (ssp. *fannini*).

Breeding Bird Surveys

A final data set available to help determine trends in the heron population is the Breeding Bird Survey. Breeding Bird Surveys are volunteer surveys co-ordinated by the Canadian Wildlife Service. Surveys are conducted as a series of 50 point counts (400 m radius) at 0.8 km intervals along a road route. Like the Christmas Bird Counts, the Breeding Bird Counts have the advantage of being unbiased by changing colony locations. The major disadvantage of Breeding Birds Count data, with Great Blue Herons, is that there is no accounting for effect of ocean tides. For example, during one year, a count could pick up dozens of herons feeding at low tide, while on another year at the same time and location, very few heron might be seen. Breeding Bird Survey data indicate a significant decline ($p<0.05$) in herons on the B.C. coast of 5.7% over the period 1966-1994 (Downes and Collins 1996).

7 LEGAL PROTECTION

Great Blue Herons nests and eggs are protected from destruction (i.e., hunting, egg-collection, etc.) under the international *Migratory Birds Convention Act* (MBCA) of 1994 signed by Canada and the USA, and within Section 5(4) of the Migratory Bird Regulations. Section 6(a). The Migratory Birds Regulations forbid the disturbance, destruction, and taking of nests or eggs. In British Columbia, similar protection is extended by Section 34 of the British Columbia *Wildlife Act* of 1982. The MBCA protects active nests, except regarding possession or sale, whereas Section 34 b) of the *Wildlife Act* protects Great Blue Heron nests year-round, regardless of whether they are active or not. Critical habitat for the Great Blue Heron is a candidate for protection under the B.C. Forest Practices Code's upcoming Volume 2 of the Identified Wildlife Management Strategy.

8 LIMITING FACTORS

8.1 Availability of Foraging Areas

Great Blue Herons are likely more limited by the availability of high quality foraging habitats than the presence of suitable nesting habitat in most areas of the coast. Along the North Coast and in the Queen Charlottes where high quality foraging areas such as tidal mudflats are more limited in distribution, herons nest at much lower densities than in areas with extensive high-quality foraging areas (e.g., Fraser River delta).

In the interior, availability of foraging habitat in winter, when most wetlands are frozen over, severely limits the winter distribution of Great Blue Herons. In coastal areas during long cold snaps, extensive areas of prime foraging areas are frozen over, and wintering populations of herons can be severely affected.

8.2 Availability of Nesting Habitat

In most areas along the B.C. coast and in the interior, availability of suitable nesting habitats is likely not a limiting factor. However, nesting habitat availability becomes a very important factor in areas of high human-use such as the Fraser River delta, the southeastern coasts of Vancouver Island, and the urban areas of the southern interior. In these areas, much of the forested lands surrounding prime foraging areas continues to be removed for agricultural, industrial and residential purposes.

8.3 Habitat Loss

Habitat destruction has resulted in the loss of several Great Blue Heron colonies in the Lower Mainland region. A colony of approximately 10 nests at Cheam Lake was destroyed when a developer removed the nest trees and the surrounding forest (Gebauer 1995a). Increasing urbanisation within some of the best nesting and foraging habitats in the province is resulting in direct loss of important heron habitats.

8.3.1 Forestry

Logging has been implicated by several authors (Bjorkland 1975; Werschkul et al. 1976) as a factor affecting herons. Logging activity will have the most significant impacts when mature timber in close proximity

to prime foraging areas is removed. In many cases, if the logging occurs outside of the breeding period of herons, birds can be expected to continue nesting in the remaining forested habitats, provided that a sufficient buffer exists. Heli-logging in proximity to colonies could lead to disturbance and potential abandonment of nests.

8.3.2 Urban development

Thompson (1982) reported declines in Great Blue Heron populations related to development activities in critical foraging and nesting areas. Watts and Bradshaw (1994) found that Great Blue Heron colonies were located farther from man-made structures and in areas where the density of structures was lower than expected given the distribution of suitable habitats. Urban development is of greatest concern where the human population is expected to continue to expand rapidly: in the Fraser River delta; in coastal areas of south-eastern Vancouver Island; and in some of the interior valleys in the Okanagan, Kootenay, and Shuswap regions. Changes in the size and/or quality of foraging areas resulting from increasing urban and industrial development, particularly in the Fraser River delta, is one of the primary threats to herons.

8.4 Food Supply

Severe winters, particularly at the northern end of their range, can result in significant over-winter mortality due to starvation (Pratt 1972). Blus and Henny (1981) reported several dead and dying herons in the Columbia Basin during a particularly severe bout of weather in 1978/79. Other factors such as climate change may result in alteration in marine upwelling patterns and zones of productivity which may directly affect prey availability and the ability of herons to meet their own energy requirements, as well as those of their chicks.

8.5 Random Environmental Effects

The data of Forbes et al. (1985b) suggest that low rainfall and/or extensive periods of sunshine favoured reproductive success. Owen (1960), as cited in Forbes et al. (1985b), found that nestling mortality in Grey Herons in Europe was inversely correlated with the quantity of rainfall. The higher mortality rates were caused by either lower foraging success of adults due to increased turbidity and rippling of the water surface or by nestlings succumbing to hypothermia brought on by the rain.

Severe winter weather has been reported as causing local population declines in Great Blue Herons in the Columbia Basin (Blus and Henny 1981). In Ohio, Burkholder and Smith (1991) found that the most important cause of nestling mortality was weather-related. Severe storms blew nestlings, and entire nests containing nestlings, out of trees. In British Columbia, observations by Roger Packham (pers. comm.) at the Muddy Lake colony near 100 Mile House indicated that 80% of the trees within the colony had fallen because of a major ice/snow event, and the Holden Lake colony near Nanaimo was abandoned for at least one year in the 1980s following a major blowdown (M. Chutter, MELP, pers. comm.). Dying trees were also a natural cause of disturbance to herons in Ohio (Burkholder and Smith 1991). In Florida, Powell and Powell (1986) concluded that harsh weather can be a significant source of heron nestling mortality, either directly from exposure, or indirectly through the depression of food accessibility. Vermeer and Anweiler (1970) documented the disturbance of heronries in Saskatchewan due to hail and flooding.

8.6 Depredation

Bald Eagles are significant predators of Great Blue Herons, particularly vulnerable unfledged chicks. Vennesland (pers. comm.) found that seven of 14 colony abandonments in southwestern British Columbia in 1998 and 1999 were a result of eagle activity, and that eagles were also likely involved in abandonment of the remaining seven colonies. Several other studies have linked Bald Eagle disturbance and depredation to heronry abandonment or lowered reproductive success (Vermeer 1973; Kelsall and Simpson 1979; Forbes 1987a; Norman et al. 1989; Hanrahan 1992). Depredation by eagles and other predators appears to be highest, relative to total number of nests, in smaller colonies (Butler et al. 1995). Breault (1988) suggested that smaller colonies were more likely to abandon under severe Bald Eagle depredation than larger colonies. There is concern that increasing Bald Eagle populations on the west coast of British Columbia (Vermeer et al. 1989; Blood and Anweiler 1994; Gebauer 1994) are resulting in increased depredation of heron colonies with implications to reproductive success and sustainability of local populations (Butler, pers. comm.).

Other wildlife species such as Common Ravens, crows, Great Horned Owls and Raccoons are also responsible for egg and chick depredation (Simpson and Kelsall 1978; Forbes et al. 1985b; Simpson et al. 1987; Gebauer 1995a and 1995b) and may affect reproductive success.

8.7 Human Disturbance

Most heron colonies are extremely sensitive to human disturbance, particularly early in the breeding cycle (Quinney 1983). Heron colony abandonments as a result of human disturbance have been widely documented (Werschkul et al. 1976; Kelsall and Simpson 1979; Forbes et al. 1985b). Urban development has been cited as the primary cause of colony abandonment in herons (Forbes et al. 1985a; Kelsall 1992). Distance between the source of disturbance and heron colonies strongly influences whether or not abandonment occurs. Where human disturbance results in temporary abandonment of eggs or chicks, increased depredation by species such as Common Ravens and crows has been reported (Taylor and Michael 1971; Simpson and Kelsall 1978; Quinney 1983; Drapeau et al. 1984; Simpson 1984; Moul 1990). In southwestern British Columbia in 1998 and 1999, Vennesland (pers. comm.) found that eagles had a much more severe impact on heron colonies (i.e., possibly involved in 14 of 14 colony abandonments) than did human disturbance (i.e., one of 14 abandonments).

8.8 Environmental Contamination

High levels of organochlorine residues have been reported from heronries on the south coast of Vancouver Island and the Lower Mainland (Elliott et al. 1988). At one site near an industrial area at Crofton, biologists found extremely high levels of dioxins that may have caused eggshell thinning and reduced reproductive success (Elliott et al. 1988 and 1989; Whitehead 1989; Sanderson et al. 1994). Hart et al. (1991) and Sanderson et al. (1994) found that high levels of dioxins at the Crofton site, although not resulting in Great Blue Heron embryo mortality, may have had adverse effects on the development of the embryos. Dioxin levels have since declined significantly and are no longer a potential threat to herons (J. Elliott, CWS, pers. comm.). High dioxin levels apparently resulted in the presence of edema and a depression of growth. Other studies that have reported effects of organochlorine and metal contaminants on Great Blue Herons include Henny and Bethers (1971); Parnell et al. (1988), Speich et al. (1992) and Spalding et al. (1994).

In Tennessee, Fleming et al. (1984) found that although eggshell thickness for Great Blue Herons was correlated with DDE concentrations (eggshell thickness averaged 7.5% thinner than eggs collected from the eastern United States before 1947, prior to DDT use), populations did not appear to be adversely affected. In 1986, Elliott et al. (1988) measured 73 eggs from four Strait of Georgia colonies and found shells to be 0.5 to 8.6% thinner than the 0.3861 mm value for heron eggs measured prior to the pesticide era (Anderson and Hickey 1972). Other authors reporting eggshell thinning in Great Blue Herons related to DDE/DDT concentrations include Speich et al. (1992) in western Washington, Laporte (1982) in Quebec, Pratt (1972) in California, and Blus et al. (1980) in Oregon and Washington. Faber et al. (1972) found that heron eggs broken during incubation were 17% below normal thickness, apparently a result of elevated DDE levels.

8.9 Other Causes

Two heron carcasses and one live heron were found entangled in monofilament line hanging from several cottonwoods near the Mary Hill Bypass colony in Port Coquitlam (Gebauer 1995a). Bird entanglements were recognised by Parnell et al. (1988) as being a frequent human-caused accident.

9 SPECIAL SIGNIFICANCE OF THE SPECIES

9.1 Status

The Great Blue Heron is currently considered to be Vulnerable in British Columbia and is Blue-listed by the B.C. Ministry of Environment, Lands and Parks (Fraser et al. 1999). Fraser et al. (1999) noted that there are fewer than 30 active colonies with more than 20 pairs of breeding birds, and the species is vulnerable to pollution, disturbance, and habitat loss. Butler (1996) recommended that the coastal *fannini* subspecies be designated as Threatened by the national Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In 1997, COSEWIC reviewed Butler's report and chose to list the *fannini* subspecies as Vulnerable in Canada, and the *herodias* subspecies as Not at Risk.

9.2 Degree of Public Interest

Great Blue Herons are of significant public interest because of their large size, conspicuous habits, and easily recognised distinctive character. The national COSEWIC Vulnerable designation received considerable media and public attention in British Columbia when it was announced in 1997, and public complaints are commonly received at government offices when heron

nesting colonies are threatened by development (M. Chutter, MELP, pers. comm.). Public outcry and action following a threat of development at the McFadden Creek heronry on Saltspring Island resulted in the long-term protection of the colony-site. Great Blue Herons are often featured in First Nations' art, local artists' paintings and on logos of environmental organisations. Herons have a high public appeal as a symbol of wetland conservation and environmental quality.

9.3 Related Species

The Great Blue Heron is very closely related to the Grey Heron of the Old World and the Cocoi Heron of South America (Butler 1997). Although these three species have distinct ranges, they are very similar morphologically, behaviourally, and genetically, suggesting that they may be races of the same species (Butler 1992a).

10 RECOMMENDATIONS AND MANAGEMENT OPTIONS

10.1 Habitat Protection and Acquisition

10.1.1 Buffer zones

Most studies have recommended a buffer distance of 250-300 m from the periphery of a heron colony, within which no human activity should take place during courtship and the nesting season (Buckley and Buckley 1976, as cited in Kelsall 1992; Bowman and Siderius 1984; Short and Cooper 1985; Vos et al. 1985; Murphy 1988; Norman 1989; Butler 1992a; Kelsall 1992). The Washington Department of Wildlife has also recommended a minimum buffer of 250-300 m from the periphery of the colony (Rodrick and Milner 1991). In Manitoba, Koonz and Rakowski (1985) recommended a 1000 m protected area around colonies and a 600 m altitude limit for aircraft. In Alberta, Markham and Brechtel (1978) recommended banning access within 500 m of heronries and a 650 m minimum altitude limit for aircraft. Larger recommended buffer distances in the prairies may be because of the high visibility of heronries in prairies environments. In Florida, Rodgers and Smith (1995) recommended set-back distances of 100 m for ground approaches and 82 m for motor boat approaches. Summers (1996) recommended the establishment of a Passive Use Buffer between 300 and 750 m around colonies, increased to 1000 m for blasting.

In a study of 19 colonies in Ohio, the highest fledgling rates were associated not with distance, but with effective barriers created by fencing and moat-like water formations that successfully limited foot-traffic (Carlson and McLean 1996). Small parcels of land were suitable for colony sites, given effective buffer zones (Carlson and Mclean 1996). An observation tower established 229 m from heron rookery islands in Illinois did not result in any overt disturbance to nesting birds (DeMauro 1993).

Vegetation structure and past history of human activity at a colony site may require variations in the buffer distances depending on the situation (Vos et al. 1985). In some cases, physical limitations will limit the width of the buffer. Buffer zones should be established prior to the arrival of herons at a breeding colony (by mid-February in coastal areas and mid-March in the interior), and maintained until early August (Butler 1991b; Summers 1996).

Summers (1996) recommended that vegetation screening be required between colonies and all development activities occurring within 100 m or less from a colony. Screening vegetation should be at least two metres high at a distance of 100 m from the edge of the colony. At distances closer than 100 m, the vegetation height will depend on its distance from the colony and the height of the nests at the nearest edge of the colony. Summers (1996) also makes specific recommendations for spacing and species composition of vegetation utilised in screening.

10.1.2 Barriers to disturbance

Carlson and McLean (1996) showed that barriers that reduced human occurrence below colonies had a stronger effect on the number of herons fledged than buffer zones around colonies. Barriers such as fences, ditches, other watercourses, and dense forests may be effective in reducing human intrusion.

10.1.3 Seasonal windows of activity

Activities that may negatively affect herons should be avoided between mid-February and early August on the coast (Butler 1991b; Summers 1996) and between March and August in the interior. The Washington Department of Wildlife recommends that all human activities within an established buffer zone be restricted during the early nesting period from 15 February to 31 July (Rodrick and Milner 1991).

10.1.4 Establishment of protected areas

Butler (1997) noted that the preservation of quality foraging habitats and nesting sites is a primary conservation need for herons in British Columbia. Major foraging areas for herons in the Strait of Georgia are eelgrass meadows, estuarine and river marshes, and abandoned grasslands. Marshes are used year-round, and old fields support many of the adult and juvenile herons in autumn and winter. Ideal nesting areas are mature woodlots free from human disturbance and within three kilometres of key foraging areas. The Washington Department of Wildlife has recommended that feeding areas, especially wetlands, be protected within a minimum radius of four kilometres of a colony-site (Rodrick and Milner 1991).

In cases where a threatened site with a long history of heron use is for sale, the Wild Bird Trust of British Columbia will consider purchasing the land.

10.1.5 Forestry prescriptions

Timber harvest plans for both private and Crown lands offer an excellent opportunity to protect future heron nesting sites. In a recent Ministry of Environment field trip to a woodlot near the Nanoose estuary (Moul, pers. obs.), tree cutting and land management plans to work within the required riparian buffer areas were discussed. The goal was to promote growth of both deciduous and coniferous stands that would reach an age class suitable for heron nests 20, 30 and 40 years in the future.

The Great Blue Heron is under consideration for inclusion in Volume 2 of Identified Wildlife Management Strategy under the Forest Practices Code of B.C. Inclusion of the heron as Identified Wildlife would greatly improve protection measures for forested habitats around heron colonies on Crown land.

10.1.6 Urban planning

Much of the recent efforts to inventory and catalogue heron nesting habitat on Vancouver Island have been directly related to land management and land development strategies (K. Morrison, pers. comm.). Efforts have been made to establish communication between B.C. Ministry of Environment, Lands and Parks wildlife personnel and regional planners. Herons can successfully nest in urban areas, e.g., near the aquarium in Stanley Park, Vancouver, and in Beacon Hill Park, Victoria. Herons have also colonised and successfully raised chicks adjacent to a golf course near the Vedder River in Sumas Prairie, Chilliwack. If regional planners are presented with a clear understanding of habitat characteristics and qualities for nesting, feeding and roosting herons, suitable habitats may be included in designs for parks, greenbelts, and subdivisions

10.1.7 Agricultural planning

Some of the most useful habitat for herons may be found in agricultural areas. Treed hedgerows in particular are used for nesting and roosting. A colony near the Vedder River, mentioned in 10.1.6, is in mature cottonwoods that form a hedgerow between ploughed fields and a golf course. The colony is protected from direct access by people and the herons appear to have habituated to periodic bands of golfers on one side and farm machinery on the other. Similarly, the colony near the Nicomekl River in the Lower Mainland is in a woodlot at the back of blueberry farm, and the colony by Kitty-Coleman Creek on Vancouver Island is in a wood-lot a hayfield's distance from the nearest roads.

Pesticide issues aside, in the Lower Mainland and adjacent Fraser River estuary, herons spend much winter foraging time in fields and along the associated drainage ditches.

10.2 Habitat Enhancement

The Delta and Farmland Trust has taken an important step in protecting upland foraging habitats by establishing grassland set-asides on farmlands. These set-asides provide habitat for a number of wildlife species, including the Townsend's Vole, a sought after prey species for herons.

Several habitat restoration programs have recently been undertaken to restore original habitats in areas affected by causeways and dikes. In Delkatla Slough, Queen Charlotte Islands, a causeway to Masset was breached, resulting in restoration of tidal flow to a large area of upland habitat (Cooper 1995). The resulting saltwater marsh and tidal flat habitats are anticipated to benefit Great Blue Herons foraging in the area. Intertidal marsh habitats were also restored in a portion of the Englishman River on Vancouver Island following breaching of a dike (Dawe and McIntosh 1993).

Nesting habitat enhancement in woodlots and along riparian buffer zones in commercial forestry areas is being actively explored by staff in the Wildlife Branch, Ministry of Environment, Lands and Parks, in Nanaimo (K. Morrison, pers. comm.).

10.3 Stewardship

Significant tidal flat and old-field foraging sites should be protected from development by long-term stewardship agreements with nearby landowners. The Canadian Wildlife Service and the B.C. Ministry of Environment, Lands and Parks launched the Heron Stewardship Program in September 1996. After Habitat Conservation Trust Fund funding was acquired, the Wild Bird Trust of British Columbia took over the stewardship agreement section of the program. The aims of the program are to secure sufficient habitat to ensure the long-term viability of heron populations around the Strait of Georgia (Butler 1997), to conduct heron population inventories (MELP), to conduct research on heron demographics (CWS), and to prepare a provincial status report (MELP). Landowners are encouraged to participate in the program by either undertaking practical enhancement techniques or entering into long-term preservation agreements.

The Wild Bird Trust has assisted in establishing stewardship and/or land securement at several large colonies including McFadden Creek, Saltspring Island, CFB Chilliwack, and Pacific Spirit Regional District Park. The Trust is currently pursuing stewardship or securement for the following medium-sized colonies: Shelbourne Refinery; Alouette River; Hassock Lake; Nicomekl River; Union Bay; Holden Lake; Drinkwater (Duncan); and Tralee (Hornby Island).

11 RESEARCH NEEDS

11.1 Population Monitoring

Long-term monitoring of Great Blue Heron populations is an important component of any heron management strategy. To date, monitoring has involved primarily the status at colony-sites in the Lower Mainland, Sunshine Coast, and eastern and southern Vancouver Island. However, a potentially large error exists in our ability to locate heron colonies, and the possibility of counting the same pairs nesting for a second and third attempt later in the season could mask population declines from wide scale abandonment. Because these methodological problems can not be easily resolved by nest count data alone, the use of a suite of factors should be considered in order to derive conclusions regarding the bird's status. Estimates of annual reproductive success as a consequence of abandonment combined with colony censuses, is promising as it ties together the more precise method of assessing reproductive success with a sample of colonies chosen to represent the population.

To complement existing research and survey efforts, systematic counts of herons on the feeding grounds may prove extremely valuable; the assumption being that the colonies may move but the major feeding grounds do not. Counts could be done at any time of year, but perhaps the best time would be during the nesting season when herons are concentrated near prime feeding areas and the larger colonies, and when the potential for migrants of the interior subspecies is low. When chicks are 6 to 10 weeks of age, virtually the entire adult population may be found feeding along the low tide line within the two-hour period before low tide. At the change of tide, when fish are no longer concentrated, large numbers of herons return to the colonies. Counts of herons at foraging areas in winter would provide an index of the entire species' winter numbers. Standardised methods (Resources Inventory Committee 1998) should be used to monitor population trends and persistence of breeding colonies. All active colonies should be monitored on an ongoing basis, and an effort should be made to identify new sites to detect trends in populations and reproductive success. Liason with the Ministry of Forests and industry will assist in identifying colonies on Crown and private timbered lands.

11.2 Contaminant Monitoring

Eggshells should be collected regularly from selected colonies and assessed for toxic levels of environmental contaminants (Fraser et al. 1999). Levels of pollutants should be monitored periodically in conjunction with data on reproductive success (Butler 1992a).

11.3 Prey-Base Monitoring

As a very useful adjunct to feeding area surveys, inventory of heron prey species in the prime feeding grounds could help determine if changes in fish stock numbers result in significant changes in heron numbers. A monitoring study of Bald Eagle prey species may also be worthwhile to show whether eagle depredation rates on heron colonies are related to the availability of other prey species.

11.4 Identification of Potential Nest Sites

Urban expansion and development within rural areas is an ongoing and presumably unstoppable trend in British

Columbia. As the majority of known heron nests are found in deciduous trees in the later stages of maturity, most known nest trees will have fallen naturally by 2010. This is especially apparent at McFadden Creek on Saltspring Island, where four of the main nest trees accounting for 15 nests collapsed in 1999 (Moul, pers. obs.). A very important aspect of future research should be the identification and enhancement of potential nesting sites. Identification of alternate nesting habitats within close proximity of existing colonies should be undertaken.

11.5 Habitat Mapping

Mapping of habitat within selected colonies will assist in identifying critical roost and buffer trees in relationship to nest trees. Mapping of foraging and potential nesting habitats will also assist in determining whether one or both of these key habitats are limiting.

12 EVALUATION

12.1 General

Great Blue Heron populations are present throughout southern British Columbia, with the largest concentrations in the Lower Mainland and southern and eastern Vancouver Island. The subspecies occurring in coastal areas is *fannini*, whereas the *herodias* subspecies occurs in interior areas of the province (Cannings 1998). Populations appear to be stable or in slight decline in most coastal areas, with the exception of the Sunshine Coast and Powell River areas where major population declines have been noted (Gebauer 1995b; Vennesland, pers. comm.). Heron populations in the interior are apparently on the increase (Cannings et al. 1987).

Although current heron populations are reasonably stable, colony-sites are extremely vulnerable to human and natural factors. Many incidences of colony abandonment due to human disturbance, land development activities, or Bald Eagle disturbance and depredation have been documented. Herons are also particularly vulnerable to the abundance and availability of food. Loss and degradation of foraging habitats in coastal areas due to development and disturbance are a significant threat to herons. Severe winters, when foraging areas are frozen over, can severely reduce the following year's breeding population.

12.2 Provincial Ranking

The Great Blue Heron is currently Blue-listed in the province and is ranked by the B.C. Conservation Data Centre as G5 globally, and S3B and S5N provincially (Fraser et al. 1999). The G ranking indicates the status of the Great Blue Heron in its entire range. The 'G5' designation indicates that it is globally common to very common, demonstrably secure, and essentially ineradicable under present conditions. The S3B rating applies to its breeding status (B) within British Columbia. A '3' ranking indicates that the Great Blue Heron is rare or uncommon (typically 21-100 occurrences) and may be susceptible to large-scale disturbances. The S5N rating applies to non-breeding status (N) within the province, which is considered to be the same as for its G ranking above. Fraser et al. (1999) noted that the Great Blue Heron is a relatively widespread species, but that there are fewer than 30 active colonies with more than 20 pairs of breeding birds, and the species is vulnerable to pollution, disturbance, and habitat loss.

The current ranking for Great Blue Heron reflects a combined ranking for both the coastal *fannini* subspecies and the interior *herodias* subspecies. Since these separate populations appear to differ in terms of population trends, movement patterns, and other life strategy factors, they have been ranked separately below. A known occurrence, as described below, is defined as any current heron nesting site containing one or more nests, its trees, and the associated foraging areas.

12.2.1 *Ardea herodias herodias*

Known occurrences: C (= 21-100 occurrences)
A total of 47 interior breeding locations has been documented (Appendix 4). Forbes et al. (1985a) documented 26 colony-sites in the southern B.C. interior and Campbell et al. (1990) noted that there were only nine colonies with more than 20 pairs in the B.C. interior. Appendix 2 lists at least 15 colonies that have contained 20 or more nests in at least one year.

Abundance: A (= less than 1000 individuals)
Based on the number of breeding and wintering records throughout the B.C. interior (Appendix 4), the interior breeding heron population is estimated to range between 300 and 700 birds. Up to 30 herons are sighted during the winter months on any one day in the Creston Valley (Butler et al. 1986), and Christmas Bird Counts of up to 29 birds have been recorded in the Okanagan (Campbell et al. 1990).

Range: C (= less than half of territory)
Great Blue Herons occurring in the interior of British Columbia are generally restricted to valley bottoms near large lakes and other significant watercourses (Campbell et al. 1990). Breeding occurs mainly in valley bottoms of the Columbia Basin, Okanagan, Merrit area, Thompson-Nicola, and sporadically north to Williams Lake and Golden. The major interior wintering areas are in the Creston Valley and the Okanagan (Butler et al. 1986; Campbell et al. 1990).

Trend: D (= increasing)
Based on data reported by Brooks and Swarth (1925), Munro and Cowan (1947), Cannings et al. 1987) and Forbes et al. (1985a), it is apparent that heron breeding populations have increased in interior areas of the province in recent years and may still be increasing.

Protected Occurrences: C (= several protected)
Great Blue Heron nest and nest trees are protected year-round under Section 34 of the *Wildlife Act*. Protected nesting areas include Vaseux Lake and Wilmer Wildlife Area in the Kootenay.

Threats: B (= moderately threatened; habitat lends itself to other uses)
Because of the location of most colony sites in lowland areas where urban development is occurring at a rapid rate, threats include habitat loss and increasing human disturbance.

Recommended Rank: S3B, S3N
A '3' ranking, for both the breeding and non-breeding seasons, indicates that the Great Blue Heron is rare or uncommon (typically 21-100 occurrences) and may be susceptible to large-scale disturbances.

Summary of Provincial Ranking
The *herodias* subspecies of the Great Blue Heron has now been reported as having bred at 47 sites in the B.C. interior (Appendix 4). Although populations appear to have increased in the later half of the 1900s, increasing urbanization adjacent to important foraging and nesting habitats in valley bottoms is a significant threat. However, this subspecies' relatively widespread distribution in the southern interior of the province will likely ensure that localised human- or weather-related impacts will not threaten the viability of the population. It is recommended that the current Blue List status of the species be maintained.

12.2.2 *Ardea herodias fannini*

Known occurrences: C (= 21-100 occurrences)
Numerous breeding locations (i.e., 195: Appendices 1, 2 and 3) have been documented in this report though many of these are not currently active. Forbes et al. (1985a) documented 85 colony-sites in southeastern B.C. up to the mid 1980s. Although many colony-sites have been reported in the Strait of Georgia and Juan de Fuca Strait, as of 1999, there are only 16 known breeding colonies that contain more than 20 pairs (Moul 2000a,b). Herons are sparse on the north coast and the Queen Charlotte Islands, and none of the few colonies exceed 20 pairs.

Abundance: C (= 3000-10,000 individuals)
Butler (1997) estimated about 4800 breeding birds in coastal areas of the province, with about 90% nesting around the Strait of Georgia. Using 1999 data and more intensive survey methodology, Moul (2000 a and b) calculated 3072 breeding birds for the Strait of Georgia area and estimated the *fannini* subspecies provincial population to range between 3000 and 6000 birds. (see 6.1.2 Coast for detailed discussion of population estimates)

An estimate of non-breeding birds during the breeding season is not available. In winter, as many as 300 herons have been estimated as using the foreshore marshes of the Fraser River delta (Butler and Campbell 1987). Butler and Cannings (1989) tallied a monthly maximum of 293 herons on foreshore areas of the delta in September 1988. Tofino Mudflats supports up to 100 herons in August of each year but few stay during the breeding season (Butler 1997).

Range: C (= less than half of territory)
Great Blue Herons on the coast are congregated in coastal areas, primarily in the Strait of Georgia, where extensive foraging areas are available. On the west coast of Vancouver Island, the North Coast, and the Queen Charlotte Islands, birds are very sparsely distributed. The major wintering area for herons on the coast is in the lower Fraser River delta.

Trend: B/C (= stable/declining?)
Fraser et al. (1999) considered coastal populations of the Great Blue Heron to be stable. Butler's 1997 estimates of 4800 birds and the author's current estimate of 3000-6000 support this on a provincial basis. However, unpublished data summarised by Moul indicates that populations in some areas may be declining (e.g., Sunshine Coast/Powell River), and potential declines could

be masked by the discovery of new colonies that may have been undiscovered for many years and therefore were present but not included in earlier estimates.

Protected Occurrences: C (= several protected)
In the Lower Fraser Valley, four colonies active in 1999, accounting for 717 active nests (67% of known active nests, including the 322 active nests in the Point Roberts colony), were protected within regional or municipal parks, or had protective status directly related to the presence of herons. On Vancouver Island and the Gulf Islands, with the acquisition of the McFadden Creek colony on Saltspring Island, 179 out of 460 (39%) of known active nests were under protective status. Ongoing efforts by Wild Bird Trust are focusing on mid-sized colonies to secure conservation covenants on private and commercial lands.

Threats: B (= moderately threatened; habitat lends itself to other uses)
Herons are sensitive to environmental contaminants and pollutants that can lead to breeding failure, heavy Bald Eagle depredation, and human disturbance. Human disturbance is a particularly significant factor in the Georgia Depression Ecoprovince where a rapidly growing human population is encroaching on valuable foraging and nesting habitats.

Recommended Rank: S3B, S5N
A '3' ranking, for the breeding season indicates that the Great Blue Heron is rare or uncommon (typically 21-100 current occurrences) and may be susceptible to large-scale disturbances. The S5N rating applies to non-breeding status (N) within the province. The '5' designation indicates that it is common to very common in winter, demonstrably secure, and essentially ineradicable under present conditions.

Summary of Provincial Ranking
The *fannini* subspecies has been reported breeding at 195 different sites along the B.C. coast, including the Queen Charlotte Islands (Appendices 1, 2 and 3). However, considerably fewer than these are likely to be active in any given year, e.g., 38 colonies were known active in 1999. Although populations appear to be stable overall, there is some indication of local declines and that reproductive success is declining, perhaps due to increased Bald Eagle depredation and human disturbance. Although breeding populations are reasonably large and are relatively widespread in coastal areas, more and more herons are nesting in the larger colonies, and the number of smaller colonies is decreasing. The potential impact of a localised disturbance, whether resulting from human or natural causes, at one of these large colonies, could have a significant impact on the overall breeding population in the region. It is recommended that the current Blue List status of the species be maintained.

13 CONTACTS

Individuals who provided information on Great Blue Heron status and occurrence in British Columbia are indicated in Appendix 5.

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15 Appendices

Appendix 1. Historical records of Great Blue Heron colonies on Vancouver Island, British Columbia, 1920 to 1999.

Appendix 2. Historical records of Great Blue Heron colonies in the Lower Fraser Valley, Sunshine Coast, and Powell River area, British Columbia, 1920 to 1999.

Appendix 3. Historical records of Great Blue Heron colonies on the North Coast and Queen Charlotte Islands, British Columbia, 1920 to 1997.

Appendix 4. Historical records of Great Blue Heron colonies in interior regions of British Columbia, 1920 to 1999.

Appendix 5. Individuals providing information on Great Blue Heron status and occurrence in British Columbia.

Appendix 1. Historical records of Great Blue Heron colonies on Vancouver Island, British Columbia, 1920 to 1999.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H101-001	Beacon Hill	Victoria	1999	48	48	46	7	10	Vennesland (2000)
H101-001	Beacon Hill	Victoria	1998	20	20	20	7	17	Moul (1999a)
H101-001	Beacon Hill	Victoria	1997	10	10	10	1	2	Moul (1998a)
H101-001	Beacon Hill	Victoria	1996	12	12	12	3		Moul (1998a)
H101-001	Beacon Hill	Victoria	1990	27	27	27	0		Breault (1990)
H101-001	Beacon Hill	Victoria	1989	55	55	31	19	45	Breault (1989)
H101-001	Beacon Hill	Victoria	1988	64	63	50	37	74	Breault (1988)
H101-002	Government House	Victoria	1999	0	0				Moul (2000a)
H101-002	Government House	Victoria	1998	5	0				Moul (1999a)
H101-002	Government House	Victoria	1997	6	6	6	0		Moul (1998a)
H101-002	Government House	Victoria	1996	7	7				Moul (1998a)
H101-003	Tillicum	Saanich	1998		0				Moul (1999a)
H101-003	Tillicum	Saanich	1997	2	0				Moul (1998a)
H101-003	Tillicum	Saanich	1996		0				Moul (1998a)
H101-003	Tillicum	Saanich	1995		0				Moul (1995)
H101-003	Tillicum	Saanich	1994		0				Moul (1994)
H101-003	Tillicum	Saanich	1993	11	11	11	0		Moul (1993)
H101-003	Tillicum	Saanich	1992	17	17	14	13	23	Moul (1992)
H101-003	Tillicum	Saanich	1991	24	24	13	0		Moul (1991)
H101-003	Tillicum	Saanich	1990	44	44	26	8	24	Breault (1990)
H101-003	Tillicum	Saanich	1989	21	21	18	12	31	Breault (1989)
H101-004	Sidney Island	Sidney	1997		0				Moul (1998a)
H101-004	Sidney Island	Sidney	1990	16	16	16	0		Butler (1997)
H101-004	Sidney Island	Sidney	1989	44	44	44	0		Butler (1997)
H101-004	Sidney Island	Sidney	1988	99	99	75	58	135	Butler (1997)
H101-004	Sidney Island	Sidney	1987	103	85	85	54	125	Butler (1997); Elliott et al. (1989)
H101-004	Sidney Island	Sidney	1986	86	51				Butler (1997); Elliott et al. (1989)
H101-004	Sidney Island	Sidney	1984	41	41	41	0		Butler (1997)
H101-004	Sidney Island	Sidney	1979	75	75				Forbes et al. (1985a)
H101-004	Sidney Island	Sidney	1974	30	30				Forbes et al. (1985a)
H101-005	McFadden Creek	Saltspring Island	1999	131	131	26	13	25	Vennesland (2000)
H101-005	McFadden Creek	Saltspring Island	1998	120	120	17	16	35	Moul (1999a)
H101-005	McFadden Creek	Saltspring Island	1997	118	118	21	19	51	Moul (1998a)
H101-005	McFadden Creek	Saltspring Island	1996	118	118				Moul (1998a)
H101-005	McFadden Creek	Saltspring Island	1990	1	1				Moul (1998a)
H101-006	Southey Point	Saltspring Island	1997		0				Moul (1998a)
H101-006	Southey Point	Saltspring Island	1989	25	21	21	15	28	Breault (1989)
H101-006	Southey Point	Saltspring Island	1980	4	4				Forbes et al. (1985a)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H101-007	Madrona Creek	Saltspring Island	1997		0				Moul (1998a)
H101-007	Madrona Creek	Saltspring Island	1996	15	0				Moul (1998a)
H101-007	Madrona Creek	Saltspring Island	1994	15	15				Moul (1998a)
H101-008	Heron Basin	Sidney	1998		0				Moul (1999a)
H101-008	Heron Basin	Sidney	1997	3	0				Moul (1998a)
H101-009	Colwood-CFB	Victoria	1999	36	0				Vennesland (2000)
H101-009	Colwood-CFB	Victoria	1998	16	16	16	0		Moul (1999a)
H101-010	Cadboro Bay	Victoria	1999	3	3				Moul (2000a)
H101-010	Cadboro Bay	Victoria	1998	1	1				Moul (1999a)
H101-011	Inskip Island	Victoria	1999		0				Moul (2000a)
H101-011	Inskip Island	Victoria	1998	5	5				Moul (1999a)
H101-012	View Royal	Victoria	1999	10	10	10	0		Moul (1999a)
H101-013	Chatham Island	Oak Bay	1929	1	1				Forbes et al. (1985a)
H101-014	Gabriola Island	Gabriola Island	1981	90	64				Forbes et al. (1985a)
H101-014	Gabriola Island	Gabriola Island	1980	60	60				Butler (1997)
H101-014	Gabriola Island	Gabriola Island	1979	30	30				Butler (1997)
H101-015	Mandarti Island	Sidney	1950	1	1				Butler (1997)
H101-015	Mandarti Island	Sidney	1945	7	7				Forbes et al. (1985a)
H101-015	Mandarti Island	Sidney	1936	1	1				Butler (1997)
H101-016	North Pender	North Pender	1974	1	1	1	1	1	Butler (1997)
H101-017	Portage Inlet	Victoria	1977	5	5				Forbes et al. (1985a)
H101-018	Prevost Island	Saltspring Island	1974	59	59				Butler (1997)
H101-019	Beddis Road	Saltspring Island	1985		0				Nina Raginsky (pers. Com.)
H101-019	Beddis Road	Saltspring Island	1981	70	70				Nina Raginsky (pers. com.)
H101-020	Saturna	Saturna Island	1920	1	1				Forbes et al. (1985a)
H101-021	Secretary Island	Gulf Islands	1935	44	44				Butler (1997)
H101-021	Secretary Island	Gulf Islands	1934	12	12				Butler (1997)
H101-021	Secretary Island	Gulf Islands	1933	4	4				Butler (1997)
H101-021	Secretary Island	Gulf Islands	1932	1	1				Butler (1997)
H101-022	Thetis Lake	Victoria	1974	1	1				Forbes et al. (1985a)
H101-022	Thetis Lake	Victoria	1962	8	8				Forbes et al. (1985a)
H101-023	South Pender	S. Pender Island	1975	1	1	1	1	2	Forbes et al. (1985a)
H101-024	Swartz Bay	Sidney	1970	1	1				Butler (1997)
H101-024	Swartz Bay	Sidney	1963	5	5				Butler (1997)
H101-025	Tsehum Harbour	Sidney	1957	1	1				Forbes et al. (1985a)
H101-026	Saanichton Bay	Saanich	1999	35	29				Moul (2000a)
H102-001	Whiffin Spit	Sooke	1999	17	16	16	0		Vennesland (2000)
H102-001	Whiffin Spit	Sooke	1998	46	40	40	0		Moul (1999a)
H102-001	Whiffin Spit	Sooke	1997	50	31	31	7	14	Moul (1998a)
H102-001	Whiffin Spit	Sooke	1996	43	43				Moul (1998a)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H102-001	Whiffin Spit	Sooke	1992	41	41				Moul (1992)
H102-001	Whiffin Spit	Sooke	1961	20	12				Butler (1997)
H102-001	Whiffin Spit	Sooke	1960	23	23				Butler (1997)
H102-002	Mill Bay	Mill Bay	1999	15	9	9	0		Vennesland (2000)
H102-002	Mill Bay	Mill Bay	1998	14	14	14	3	7	Moul (1999a)
H102-002	Mill Bay	Mill Bay	1997	8	8	3	3	7	Moul (1998a)
H102-003	Otter Point	Sooke	1961	8	8				Forbes et al. (1985a)
H102-003	Otter Point	Sooke	1960	6	6				Butler (1997)
H102-004	Stoney Creek	Sooke	1961	2	2				Butler (1997)
H102-005	Cherry Point	Cowichan Bay	1939	1	1				Forbes et al. (1985a)
H104-001	Quamichan Lake	Duncan	1997		0				Moul (1998a)
H104-001	Quamichan Lake	Duncan	1994		0				Moul (1994)
H104-001	Quamichan Lake	Duncan	1993	11	11	11	0		Moul (1993)
H104-001	Quamichan Lake	Duncan	1992	19	19	19	0		Moul (1992)
H104-001	Quamichan Lake	Duncan	1991	28	28	27	24	61	Moul (1991)
H104-001	Quamichan Lake	Duncan	1990	28	28	28	20	56	Breault (1990)
H104-001	Quamichan Lake	Duncan	1989	32	32	30	27	68	Breault (1989)
H104-002	Sahtlam	Duncan	1997		0				Moul (1998a)
H104-002	Sahtlam	Duncan	1996	11	0				Moul (1998a)
H104-002	Sahtlam	Duncan	1991	15	0				Moul (1991)
H104-002	Sahtlam	Duncan	1990	3	3	3	2	3	Breault (1990)
H104-002	Sahtlam	Duncan	1989	6	6	6	4	9	Breault (1989)
H104-003	Drinkwater Road	Duncan	1999	85	71	34	27	46	Vennesland (2000)
H104-003	Drinkwater Road	Duncan	1998	26	26	26			Moul (1999a)
H104-003	Drinkwater Road	Duncan	1997	35	19	19	5	14	Moul (1998a)
H104-004	Youbou	Cowichan Lake	1997		0				Moul (1998a)
H104-004	Youbou	Cowichan Lake	1990	1	1	1	1	2	Breault (1990)
H104-004	Youbou	Cowichan Lake	1989	1	1	1	1	4	Breault (1989)
H104-005	Cobble Hill	Duncan	1979	1	1				Forbes et al. (1985a)
H104-005	Cobble Hill	Duncan	1978	6	6				Forbes et al. (1985a)
H104-006	Cowichan	Duncan	1990	1	1	1	0		Butler (1997)
H104-006	Cowichan	Duncan	1989	1	1	1	0		Butler (1997)
H104-007	Cowichan Bay Village	Cowichan Bay	1979	34	28				Forbes et al. (1985a)
H104-007	Cowichan Bay Village	Cowichan Bay	1973	12	12				Forbes et al. (1985a)
H104-007	Cowichan Bay Village	Cowichan Bay	1952	32	32				Butler (1997)
H104-007	Cowichan Bay Village	Cowichan Bay	1950	32					Forbes et al. (1985a)
H104-007	Cowichan Bay Village	Cowichan Bay	1945	2	2				Butler (1997)
H104-007	Cowichan Bay Village	Cowichan Bay	1931	8	8				Butler (1997)
H104-008	Cowichan Station	Cowichan Bay	1979		0				Forbes et al. (1985a)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H104-008	Cowichan Station	Cowichan Bay	1977	8	8				Forbes et al. (1985a)
H104-008	Cowichan Station	Cowichan Bay	1975	27	27				Forbes et al. (1985a)
H104-008	Cowichan Station	Cowichan Bay	1973	12	12				Forbes et al. (1985a)
H104-008	Cowichan Station	Cowichan Bay	1972	9	7				Forbes et al. (1985a)
H104-009	Genoa Bay	Cowichan Bay	1979	9	9				Butler (1997)
H104-009	Genoa Bay	Cowichan Bay	1975		0				Forbes et al. (1985a)
H104-009	Genoa Bay	Cowichan Bay	1972	17	10				Forbes et al. (1985a)
H104-009	Genoa Bay	Cowichan Bay	1971	22	22				Forbes et al. (1985a)
H104-009	Genoa Bay	Cowichan Bay	1970	16	13				Forbes et al. (1985a)
H105-001	Shoal Island	Crofton	1998		0				Moul (1999a)
H105-001	Shoal Island	Crofton	1997	20	0				Moul (1998a)
H105-001	Shoal Island	Crofton	1996		0				Moul (1998a)
H105-001	Shoal Island	Crofton	1995	40	40	40	0		Moul (1995)
H105-001	Shoal Island	Crofton	1994	63	63	57	22	62	Moul (1994)
H105-001	Shoal Island	Crofton	1993	63	63	52	14	36	Moul (1993)
H105-001	Shoal Island	Crofton	1992	61	61	52	16	34	Moul (1992)
H105-001	Shoal Island	Crofton	1991	47	47	42	30	75	Moul (1991)
H105-001	Shoal Island	Crofton	1990	32	32	31	22	69	Breault (1990)
H105-001	Shoal Island	Crofton	1989	25	25	25	21	55	Moul (1990)
H105-001	Shoal Island	Crofton	1988	35	35	35	0		Moul (1990)
H105-001	Shoal Island	Crofton	1987	60	57	60	0		Butler (1989); Elliott et al. (1989)
H105-001	Shoal Island	Crofton	1986	64	64		40		Elliott et al. (1989)
H105-001	Shoal Island	Crofton	1982	20					Forbes et al. (1985a)
H105-001	Shoal Island	Crofton	1979	1	1				Butler (1997)
H105-001	Shoal Island	Crofton	1975	75	75				Butler (1997)
H105-001	Shoal Island	Crofton	1974	130	85				Butler (1997)
H105-001	Shoal Island	Crofton	1973	59	52				Butler (1997)
H105-001	Shoal Island	Crofton	1970	40	40				Butler (1997)
H105-002	Holden Lake	Nanaimo	1999	43	26	20	8	17	Vennesland (2000)
H105-002	Holden Lake	Nanaimo	1998	21	21	20	17	44	Moul (1999a)
H105-002	Holden Lake	Nanaimo	1997	72	16	16	3	5	Moul (1999a)
H105-002	Holden Lake	Nanaimo	1996	90	72				Moul (1998a)
H105-002	Holden Lake	Nanaimo	1995	90	90				Moul (1995)
H105-002	Holden Lake	Nanaimo	1994	104	83				Moul (1994)
H105-002	Holden Lake	Nanaimo	1993	101	86	86	39	65	Moul (1993)
H105-002	Holden Lake	Nanaimo	1992	115	113	78	73	154	Moul (1992)
H105-002	Holden Lake	Nanaimo	1991	120	90	37	31	53	Moul (1991)
H105-002	Holden Lake	Nanaimo	1990	132	132		36	107	Breault (1990)
H105-002	Holden Lake	Nanaimo	1989	162	162	45	38	73	Breault (1989)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H105-002	Holden Lake	Nanaimo	1988	100	100	44	41	75	Breault (1988)
H105-003	Hammond Bay	Nanaimo	1992	0	0				Moul (1992)
H105-003	Hammond Bay	Nanaimo	1991	15	15	15	0		Moul (1991)
H105-003	Hammond Bay	Nanaimo	1990	19	19	17	14	37	Breault (1990)
H105-003	Hammond Bay	Nanaimo	1989	16	16	15	9	19	Berault (1989)
H105-003	Hammond Bay	Nanaimo	1988	24	24	22	13	21	Breault (1988)
H105-004	Brannen Lake	Nanaimo	1997	0	0				Moul (1998a)
H105-004	Brannen Lake	Nanaimo	1992	7	7	7	0		Moul (1992)
H105-004	Brannen Lake	Nanaimo	1991	2	2				MELP files
H105-005	Northwest Bay	Parksville	1997	0	0				Moul (1998a)
H105-005	Northwest Bay	Parksville	1992		0				Moul (1992)
H105-005	Northwest Bay	Parksville	1991	8	8	8	1	2	Moul (1991)
H105-005	Northwest Bay	Parksville	1990	11	11		8	28	Breault (1990)
H105-005	Northwest Bay	Parksville	1989	8	8	8	7	19	Breault (1989)
H105-006	Soriel Road	Parksville	1998		0				Moul (1999a)
H105-006	Soriel Road	Parksville	1997	1	0				Moul (1998a)
H105-006	Soriel Road	Parksville	1993	4	4				Moul (1993)
H105-007	Protection Island	Nanaimo	1999		0				Moul (2000a)
H105-007	Protection Island	Nanaimo	1998	9	0				Moul (1999a)
H105-007	Protection Island	Nanaimo	1997	5	5				Moul (1998a)
H105-008	Beachcomber	Nanoose Bay	1999	10	3	3	0		Vennesland (2000)
H105-008	Beachcomber	Nanoose Bay	1998	12	12	12	4	7	Moul (1999a)
H105-008	Beachcomber	Nanoose Bay	1997	5	5				Moul (1998a)
H105-009	Cottle Creek	Nanaimo	1999	4	0				Moul (2000a)
H105-009	Cottle Creek	Nanaimo	1998	7	7				Moul (1999a)
H105-010	Jingle Pot Road	Nanaimo	1999	0	0				Moul (2000a)
H105-011	Ladysmith	Ladysmith	1939	1	1				Forbes et al. (1985a)
H105-012	Cedar Road	Nanaimo	1981	60					Forbes et al. (1985a)
H105-013	Extension	Nanaimo	1981	1	1				Forbes et al. (1985a)
H105-013	Extension	Nanaimo	1980	1	1				Forbes et al. (1985a)
H105-013	Extension	Nanaimo	1972	3	3				Butler (1997)
H105-014	Yellowpoint	Ladysmith	1972	10	10				Forbes et al. (1985a)
H105-015	Nanoose	Nanoose Bay	1980	8	8				Butler (1997)
H105-016	Parksville	Parksville	1981	6	6				Forbes et al. (1985a)
H105-017	Acacia Road	Parksville	1992	1	1	1	0		Moul (1992)
H105-017	Acacia Road	Parksville	1991	1	1	1	0		Moul (1991)
H105-017	Acacia Road	Parksville	1990	1	1	1	1	4	Butler (1997)
H105-017	Acacia Road	Parksville	1989	1	1	1	1	4	Butler (1997)
H105-017	Acacia Road	Parksville	1988	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1987	1	1	1	1		Moul (1992)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H105-017	Acacia Road	Parksville	1986	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1985	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1984	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1983	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1982	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1981	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1980	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1979	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1978	1	1	1	1		Moul (1992)
H105-017	Acacia Road	Parksville	1977	1	1	1	1		Moul (1992)
H105-018	Gravel Pitt	Parksville	1990	10	10	10	0		Butler (1997)
H105-018	Gravel Pitt	Parksville	1989	9	9	9	9	23	Butler (1997)
H105-019	Industrial Way	Parksville	1988	4	4		0		Breault (1988)
H105-019	Industrial Way	Parksville	1987	1	1				Breault (1988)
H105-020	Englishman River	Parksville	1999	4	4				Moul (2000a)
H106-001	North-west	Denman Island	1998	13	0				Moul (1999a)
H106-001	North-west	Denman Island	1997	22	3	3	1		Moul (1998a)
H106-001	North-west	Denman Island	1996	22	22				Moul (1998a)
H106-001	North-west	Denman Island	1991	14	14	14	2	4	Moul (1991)
H106-001	North-west	Denman Island	1990	4	4	4	1	3	Breault (1990)
H106-001	North-west	Denman Island	1989	17	17	17	16	46	Breault (1989)
H106-002	North End	Denman Island	1998	0	0				Moul (1999a)
H106-002	North End	Denman Island	1997	5	0				Moul (1998a)
H106-002	North End	Denman Island	1996	5	0				Moul (1998a)
H106-002	North End	Denman Island	1991	5	5	5	0		Moul (1991)
H106-002	North End	Denman Island	1990	18	18	18	0		Breault (1990)
H106-002	North End	Denman Island	1989	5	5	5	2	5	Breault (1989)
H106-002	North End	Denman Island	1980	9					Forbes et al. (1985a)
H106-003	Denman Point	Denman Island	1999	11	0				Vennesland (2000)
H106-003	Denman Point	Denman Island	1998		0				Moul (1999a)
H106-003	Denman Point	Denman Island	1997	11	3	3	0		Moul (1998a)
H106-003	Denman Point	Denman Island	1996	11	11				Moul (1998a)
H106-003	Denman Point	Denman Island	1991	22	22	22	11	29	Moul (1991)
H106-003	Denman Point	Denman Island	1990	24	24	24	15	46	Berault (1990)
H106-003	Denman Point	Denman Island	1989	24	24	20	13	37	Berault (1989)
H106-004	Fillongley South	Denman Island	1996	13	0				Moul (1998a)
H106-004	Fillongley South	Denman Island	1991	13	0				Moul (1991)
H106-004	Fillongley South	Denman Island	1990	18	18	15	5	15	Berault (1990)
H106-004	Fillongley South	Denman Island	1989	15	15	14	7	16	Berault (1989)
H106-005	Landing	Hornby Island	1998	0	0				Moul (1999a)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H106-005	Landing	Hornby Island	1997	0	0				Moul (1998a)
H106-005	Landing	Hornby Island	1991	10	10	10	0		Moul (1991)
H106-005	Landing	Hornby Island	1990	9	9	5	4	11	Berault (1990)
H106-005	Landing	Hornby Island	1989	7	7	6	6	22	Berault (1989)
H106-006	Tralee 1	Hornby Island	1998	0	0				Moul (1999a)
H106-006	Tralee 1	Hornby Island	1997	7	0				Moul (1998a)
H106-006	Tralee 1	Hornby Island	1996	7	0				Moul (1998a)
H106-006	Tralee 1	Hornby Island	1991	0	0				Moul (1991)
H106-006	Tralee 1	Hornby Island	1990	17	17	17	4	10	Berault (1990)
H106-006	Tralee 1	Hornby Island	1989	15	15	15	15	34	Berault (1989)
H106-007	Tralee 2	Hornby Island	1998	0	0				Moul (1999a)
H106-007	Tralee 2	Hornby Island	1997	12	0				Moul (1998a)
H106-007	Tralee 2	Hornby Island	1996	12	2				Moul (1998a)
H106-007	Tralee 2	Hornby Island	1991	26	26	23	18	38	Moul (1991)
H106-007	Tralee 2	Hornby Island	1990	9	9	9	1	3	Berault (1990)
H106-007	Tralee 2	Hornby Island	1989	18	18	18	17	48	Berault (1989)
H106-008	Tralee Point	Hornby Island	1999	53	50	50	13	23	Vennesland (2000)
H106-008	Tralee Point	Hornby Island	1998	50	44	44	36	62	Moul (1999a)
H106-008	Tralee Point	Hornby Island	1997	40	38	24	17	48	Moul (1998a)
H106-008	Tralee Point	Hornby Island	1996	50	50				Moul (1998a)
H106-008	Tralee Point	Hornby Island	1991	0	0				Moul (1991)
H106-008	Tralee Point	Hornby Island	1990	32	32	24	22	42	Berault (1990)
H106-009	Fanny Bay	Fanny Bay	1997	3	0				Moul (1998a)
H106-009	Fanny Bay	Fanny Bay	1996	3	0				Moul (1998a)
H106-009	Fanny Bay	Fanny Bay	1991	10	0				Moul (1991)
H106-009	Fanny Bay	Fanny Bay	1988	15	15	15	3	7	Breault (1988)
H106-010	Union Bay South	Union Bay	1997	0	0				Moul (1998a)
H106-010	Union Bay South	Union Bay	1996		0				Moul (1998a)
H106-010	Union Bay South	Union Bay	1992		0				Moul (1992)
H106-010	Union Bay South	Union Bay	1991	8	6				Moul (1991)
H106-011	Union Bay North	Union Bay	1997	0	0				Moul (1998a)
H106-011	Union Bay North	Union Bay	1996	0	0				Moul (1998a)
H106-011	Union Bay North	Union Bay	1991	2	0				Moul (1991)
H106-011	Union Bay North	Union Bay	1988	6	6	6	3	6	Breault (1988)
H106-012	Union Bay	Union Bay	1999	26	19				Gebauer (unpublished)
H106-012	Union Bay	Union Bay	1998	5	0				Moul (1999a)
H106-013	Little River	Comox	1998	0	0				Moul (1999a)
H106-013	Little River	Comox	1997	14	0				Moul (1998a)
H106-013	Little River	Comox	1996	24	0				Moul (1996)
H106-013	Little River	Comox	1992	44	44	32	32	72	Moul (1992)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H106-013	Little River	Comox	1991	28	28	25	24	57	Moul (1991)
H106-013	Little River	Comox	1990	27	27	20	16	62	Breault (1990)
H106-013	Little River	Comox	1989	22	22	18	16	44	Breault (1989)
H106-014	Royston	Royston	1999	27	27	27	0		Vennesland (2000)
H106-014	Royston	Royston	1998	30	25	25	9	23	Moul (1999a)
H106-014	Royston	Royston	1997	19	18	5	5	13	Moul (1998a)
H106-015	Kitty-coleman Creek	Merville	1999	31	1	1	0		Vennesland (2000)
H106-015	Kitty-coleman Creek	Merville	1998	31	17	17	0		Moul (1999a)
H106-015	Kitty-coleman Creek	Merville	1997	25	19	8	8	14	Moul (1998a)
H106-016	Cougar Creek	Fanny Bay	1987	2	2				MELP files
H106-017	Rosewall Creek	Fanny Bay	1987	10	10				MELP files
H106-018	Cook Creek	Fanny Bay	1987	2	2				MELP files
H106-019	Cougar Smith Creek	Fanny Bay	1987	9	9				MELP files
H106-020	Cumberland Road	Comox	1980	19	19				Butler (1997)
H106-021	Bowser	Bowser	1976		0				Forbes et al. (1985a)
H106-021	Bowser	Bowser	1975	18	18				Butler (1997)
H106-022	Killman Road	Union Bay	1999	5	5				Moul (2000a)
H106-023	Whalebone Point	Denman Island	1981	70	70				Forbes et al. (1985a)
H106-023	Whalebone Point	Denman Island	1980	45	45				Forbes et al. (1985a)
H106-024	C.R. Airport	Campbell River	1988	1	1				Breault (1988)
H106-025	Hornby	Hornby Island	1966	34					Forbes et al. (1985a)
H106-025	Hornby	Hornby Island	1962	16	16				Forbes et al. (1985a)
H106-025	Hornby	Hornby Island	1961	33	30				Forbes et al. (1985a)
H106-025	Hornby	Hornby Island	1960	30	30				Forbes et al. (1985a)
H106-025	Hornby	Hornby Island	1959	30					Forbes et al. (1985a)
H106-026	St. John's Point	Hornby Island	1962	1	1				Forbes et al. (1985a)
H107-001	Somass River	Port Alberni	1992		0				Moul (1992)
H107-001	Somass River	Port Alberni	1971	10	10				Butler (1997)
H107-002	Alberni Inlet west	Port Alberni	1999		0				Moul (2000a)
H110-001	Elk Falls	Campbell River	1987	10	10	10	0		MELP files
H110-002	Tree Nursery A	Campbell River	1987	15	0				MELP files
H110-003	Tree Nursery B	Campbell River	1988	3	3	3	0		Breault (1988)
H110-004	Tree Nursery C	Campbell River	1988	2	2				Breault (1988)
H110-005	Menzies Bay	Campbell River	1997	1					MELP files
H112-001	Ceepeecee	Ceepeecee	1991	4	4				MELP files
H112-002	Tahsis	Tahsis	1989	10	10				Breault (1989))
H115-001	Smelt Bay	Cortes Island	1999	3	3				Moul (2000a)
H115-001	Smelt Bay	Cortes Island	1998	5	2				Moul (1999a)
H115-001	Smelt Bay	Cortes Island	1997	0	0				Moul (1998a)

Appendix 1. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H115-001	Smelt Bay	Cortes Island	1996	0	0				Moul (1998a)
H115-001	Smelt Bay	Cortes Island	1992	12	12	12	2	2	Moul (1992)
H115-001	Smelt Bay	Cortes Island	1991	11	11	10	5	11	Moul (1991)
H115-001	Smelt Bay	Cortes Island	1980		0				Forbes et al. (1985a)
H115-001	Smelt Bay	Cortes Island	1979	22	22				Butler (1997)
H115-002	Hague Lake	Cortes Island	1997	0	0				Moul (1998a)
H115-002	Hague Lake	Cortes Island	1996	3	0				Moul (1998a)
H115-002	Hague Lake	Cortes Island	1993	7	7				Moul (1998a)
H115-003	Whaletown	Cortes Island	1998		0				Moul (1999a)
H115-003	Whaletown	Cortes Island	1997	3	0				Moul (1998a)
H115-003	Whaletown	Cortes Island	1996	3	0				Moul (1998a)
H115-003	Whaletown	Cortes Island	1993	4	4				Moul (1998a)
H115-003	Whaletown	Cortes Island	1988	6	5				George Sirk (pers. com.)
H115-004	Gowlland Island	Quadra Island	1988	4	0				Breault (1988)
H115-005	Heriot Bay	Quadra Island	1999	5	5	5	0		Moul (2000a)
H115-006	Hyacinthe Bay	Quadra Island	1989	5	5	5	0		Moul (2000a)
H115-006	Hyacinthe Bay	Quadra Island	1988	3	3	3	3		Moul (2000a)
H115-006	Hyacinthe Bay	Quadra Island	1980		0				Forbes et al. (1985a)
H115-006	Hyacinthe Bay	Quadra Island	1979	8					Forbes et al. (1985a)
H115-007	Yaculta Village	Quadra Island	1987	1	1				Breault (1988)
H115-008	Cape Mudge	Quadra Island	1988	20	0				Breault (1988)

Appendix 2. Historical records of Great Blue Heron colonies in the Lower Fraser Valley, Sunshine Coast and Powell River areas, British Columbia, 1920 to 1999.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H202-001	Greenwood Island	Hope	1979	10	10				Butler (1997)
H202-001	Greenwood Island	Hope	1973	1	1				Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1999	322	322	140	134	231	Vennesland (2000); Ann Eissinger (pers. com.)
H204-001	Point Roberts	Point Roberts	1998	337	304	272	233	534	Ann Eissinger
H204-001	Point Roberts	Point Roberts	1997	393	294	328		537	Ann Eissinger
H204-001	Point Roberts	Point Roberts	1996	444	444				Ann Eissinger
H204-001	Point Roberts	Point Roberts	1995	472	472				Butler (1997)
H204-001	Point Roberts	Point Roberts	1994	414	414				Butler (1997)
H204-001	Point Roberts	Point Roberts	1993	400	400				Butler (1997)
H204-001	Point Roberts	Point Roberts	1992	474	235	25	25	76	Gebauer (1995a)
H204-001	Point Roberts	Point Roberts	1991	387	387				Butler (1997)
H204-001	Point Roberts	Point Roberts	1990	300	300				Butler (1997)
H204-001	Point Roberts	Point Roberts	1989	253	253				Butler (1997)
H204-001	Point Roberts	Point Roberts	1988	335	335				Butler (1997)
H204-001	Point Roberts	Point Roberts	1987	253	253				Butler (1997)
H204-001	Point Roberts	Point Roberts	1986	220	220				Butler (1997)
H204-001	Point Roberts	Point Roberts	1981	220	220	50	50	122	Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1980	250	222	53	53	156	Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1979	247	236	33	33	96	Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1978	226	210	39	39	98	Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1977	216	183	39	39	109	Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1974	30	30				Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1973	30	30				Forbes et al. (1985a)
H204-001	Point Roberts	Point Roberts	1970	1	1				Forbes et al. (1985a)
H204-002	Nicomekl	Crescent Beach	1999	34	34	30	15	36	Vennesland (2000)
H204-002	Nicomekl	Crescent Beach	1998	37	37	37	36	93	Vennesland (2000)
H204-002	Nicomekl	Crescent Beach	1997	30	30	7	7	19	Moul (1998b)
H204-002	Nicomekl	Crescent Beach	1995	35	35				Butler (1997)
H204-002	Nicomekl	Crescent Beach	1994	30	30				Gebauer (1995a)
H204-002	Nicomekl	Crescent Beach	1993	36	36				Gebauer (1995a)
H204-002	Nicomekl	Crescent Beach	1992	36	36	34	32	108	Gebauer (1995a)
H204-002	Nicomekl	Crescent Beach	1990	40	40	37	37	81	Butler (1997)
H204-002	Nicomekl	Crescent Beach	1988	38	38	30	25	59	Butler (1997)
H204-002	Nicomekl	Crescent Beach	1987	55	55	55	29		Elliott et al. (1989)
H204-002	Nicomekl	Crescent Beach	1986	23	23	23	12	25	Elliott et al. (1989)
H204-003	Serpentine	Surrey	1999		0				Vennesland (2000)
H204-003	Serpentine	Surrey	1998	8	8	8	0		Vennesland (2000)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H204-003	Serpentine	Surrey	1997	13	10	10	9	22	Moul (1998b)
H204-003	Serpentine	Surrey	1994	5	5				Gebauer (1995a)
H204-004	South # 7 Road	Richmond	1997	0	0				Moul (1998b)
H204-004	South # 7 Road	Richmond	1992	12	12	6	0		Gebauer (1995a)
H204-004	South # 7 Road	Richmond	1991	12	12	12	0		Butler (1997)
H204-004	South # 7 Road	Richmond	1989	16	12				Gebauer (1995a)
H204-004	South # 7 Road	Richmond	1987	7	7				Butler (1997)
H204-004	South # 7 Road	Richmond	1984	1	1				Forbes et al. (1985a)
H204-005	Cessna Way	Richmond	1997	2	0				Moul (1998b)
H204-005	Cessna Way	Richmond	1992	12	0				Gebauer (1995a)
H204-005	Cessna Way	Richmond	1981	4	4		3	7	Forbes et al. (1985a)
H204-006	Derby Reach	Langley	1997	5	0				Moul (1998b)
H204-006	Derby Reach	Langley	1994	0	0				Gebauer (1995a)
H204-006	Derby Reach	Langley	1993	0	0				Gebauer (1995a)
H204-006	Derby Reach	Langley	1992	37	0				Gebauer (1995a)
H204-006	Derby Reach	Langley	1991	40	40	40	0		Gebauer (1995a)
H204-006	Derby Reach	Langley	1981	33	31	15	12	32	Butler (1997)
H204-006	Derby Reach	Langley	1980	38	30				Butler (1997)
H204-006	Derby Reach	Langley	1979	38	38		12	37	Butler (1997)
H204-006	Derby Reach	Langley	1978	31	31				Butler (1997)
H204-006	Derby Reach	Langley	1977	16	16				Butler (1997)
H204-006	Derby Reach	Langley	1976	20	20				Butler (1997)
H204-006	Derby Reach	Langley	1975	18	18				Butler (1997)
H204-006	Derby Reach	Langley	1974	17	17				Butler (1997)
H204-007	N Delta River Road	North Delta	1998		0				Vennesland (2000)
H204-007	N Delta River Road	North Delta	1997	0	0				Moul (1998b)
H204-007	N Delta River Road	North Delta	1994		0				Gebauer (1995a)
H204-007	N Delta River Road	North Delta	1993		0				Gebauer (1995a)
H204-007	N Delta River Road	North Delta	1992	6	6	6	0		Gebauer (1995a)
H204-008	Chilliwack City	Chilliwack	1998	0	0				Vennesland (2000)
H204-008	Chilliwack City	Chilliwack	1997	15	15	15	0		Moul (1998b)
H204-008	Chilliwack City	Chilliwack	1994	15	12				Gebauer (1995a)
H204-008	Chilliwack City	Chilliwack	1993	5	5				Gebauer (1995a)
H204-009	CFB Chilliwack	Chilliwack	1999	114	114	27	22	44	Vennesland (2000)
H204-009	CFB Chilliwack	Chilliwack	1998	83	83	83	82	184	Vennesland (2000)
H204-009	CFB Chilliwack	Chilliwack	1997	93	80	12	8	18	Moul (1998b)
H204-009	CFB Chilliwack	Chilliwack	1994	140	140				Gebauer (1995a)
H204-009	CFB Chilliwack	Chilliwack	1993	140	140				Gebauer (1995a)
H204-009	CFB Chilliwack	Chilliwack	1992	152	152	152	54	152	Gebauer (1995a)
H204-009	CFB Chilliwack	Chilliwack	1980	104	91		43	113	Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H204-009	CFB Chilliwack	Chilliwack	1979	110	109				Forbes et al. (1985a)
H204-009	CFB Chilliwack	Chilliwack	1978	101	101				Forbes et al. (1985a)
H204-009	CFB Chilliwack	Chilliwack	1977	96	88		34	89	Forbes et al. (1985a)
H204-009	CFB Chilliwack	Chilliwack	1976	50	50				Forbes et al. (1985a)
H204-010	Vedder Canal	Chilliwack	1999	3	3	3	0		Vennesland (2000)
H204-010	Vedder Canal	Chilliwack	1998	2	2	2	2	5	Vennesland (2000)
H204-010	Vedder Canal	Chilliwack	1997	3	3	3	3	10	Moul (1999b)
H204-011	Boundary Bay	Delta	1998		0				Moul (1999b)
H204-011	Boundary Bay	Delta	1997		0				Moul (1998b)
H204-011	Boundary Bay	Delta	1996	14	0				Butler (1997)
H204-012	Tilbury Island	Delta	1999	12	12	10	8	19	Vennesland (2000)
H204-012	Tilbury Island	Delta	1998	8	8	8	8	22	Vennesland (2000)
H204-013	White Rock	White Rock	1962	1	1				Forbes et al. (1985a)
H204-014	Crescent Beach	South Surrey	1980	41	41		22	50	Forbes et al. (1985a)
H204-014	Crescent Beach	South Surrey	1979	42	42		13	40	Forbes et al. (1985a)
H204-014	Crescent Beach	South Surrey	1978	46	46		17	47	Forbes et al. (1985a)
H204-014	Crescent Beach	South Surrey	1977	39	37		18	53	Forbes et al. (1985a)
H204-014	Crescent Beach	South Surrey	1968	1	1				Forbes et al. (1985a)
H204-014	Crescent Beach	South Surrey	1967	1	1				Forbes et al. (1985a)
H204-015	Sea Island 2	Richmond	1992	12	12				Butler (1997)
H204-015	Sea Island 2	Richmond	1987	7	7				Butler (1997)
H204-016	Fort Langley	Langley	1963	12	12				Forbes et al. (1985a)
H204-016	Fort Langley	Langley	1944	1	1				Forbes et al. (1985a)
H204-017	Tsawwassen	Tsawwassen	1961	1	1				Butler (1997)
H204-017	Tsawwassen	Tsawwassen	1960		0				Butler (1997)
H204-017	Tsawwassen	Tsawwassen	1959	100	100				Forbes et al. (1985a)
H204-017	Tsawwassen	Tsawwassen	1958	100	100				Butler (1997)
H204-017	Tsawwassen	Tsawwassen	1956	85	85				Butler (1997)
H204-017	Tsawwassen	Tsawwassen	1955	85	85				Butler (1997)
H204-017	Tsawwassen	Tsawwassen	1949	185	185				Forbes et al. (1985a)
H204-017	Tsawwassen	Tsawwassen	1948	165	165				Forbes et al. (1985a)
H204-018	Douglas Island	Port Coquitlam	1977	1	1				Forbes et al. (1985a)
H204-018	Douglas Island	Port Coquitlam	1973	1	1				Forbes et al. (1985a)
H204-019	Poplar Island	New Westminister	1974	10	10				Forbes et al. (1985a)
H204-019	Poplar Island	New Westminister	1973	1	1				Forbes et al. (1985a)
H204-020	McGillivray Slough	Sumas Mt.	1977	51	46				Forbes et al. (1985a)
H204-020	McGillivray Slough	Sumas Mt.	1974	27					Forbes et al. (1985a)
H204-020	McGillivray Slough	Sumas Mt.	1920	1	1				Forbes et al. (1985a)
H204-021	McMillian Island	Fort Langley	1964	35	35				Forbes et al. (1985a)
H204-022	Mount Lehman	Abbotsford	1988	1	1				Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H204-022	Mount Lehman	Abbotsford	1970	10	10				Forbes et al. (1985a)
H204-023	Sea Island 1	Richmond	1949	40	40				Forbes et al. (1985a)
H204-023	Sea Island 1	Richmond	1945	40	40				Forbes et al. (1985a)
H204-023	Sea Island 1	Richmond	1943	40	40				Forbes et al. (1985a)
H204-023	Sea Island 1	Richmond	1941	40	40				Forbes et al. (1985a)
H205-001	Paq Lake	Pender Harbour	1997	0	0				Moul (1998b)
H205-001	Paq Lake	Pender Harbour	1994	8	8				Gebauer (1995b)
H205-001	Paq Lake	Pender Harbour	1993	10	10	10	8	11	Gebauer (1995b)
H205-001	Paq Lake	Pender Harbour	1992	5	5	5	1	2	Moul (1992)
H205-002	Halfmoon Bay	Halfmoon Bay	1999	5	3	3	0		Vennesland (2000)
H205-002	Halfmoon Bay	Halfmoon Bay	1998	3	3				Moul (1999b)
H205-002	Halfmoon Bay	Halfmoon Bay	1997	7	0				Moul (1998b)
H205-002	Halfmoon Bay	Halfmoon Bay	1994	19	19				Gebauer (1995b)
H205-002	Halfmoon Bay	Halfmoon Bay	1993	16	14	14	12	20	Gebauer (1995b)
H205-003	Acorn Street	Sechelt	1999	5	5	5	0		Vennesland (2000)
H205-003	Acorn Street	Sechelt	1998	2	2	2	0		Moul (1999b)
H205-003	Acorn Street	Sechelt	1997	6	6	6	1		Moul (1998b)
H205-003	Acorn Street	Sechelt	1994	1	1				Gebauer (1995b)
H205-003	Acorn Street	Sechelt	1993	11	11	11	3	6	Gebauer (1995b)
H205-004	Stewart Road	Gibsons	1997		0				Moul (1998b)
H205-004	Stewart Road	Gibsons	1994	2	2	2	0		Butler (1997)
H205-004	Stewart Road	Gibsons	1993	4	4	4	0		Butler (1997))
H205-005	Storm Bay	Sechelt Inlet	1997		0				Moul (1998b)
H205-005	Storm Bay	Sechelt Inlet	1993	10	10				Gebauer (1995b)
H205-006	Sutton Islets	Egmont	1999		0				Vennesland (2000)
H205-006	Sutton Islets	Egmont	1998	5	5	5	0		Vennesland (2000)
H205-006	Sutton Islets	Egmont	1997	0	0				Moul (1998b)
H205-006	Sutton Islets	Egmont	1994	1	1				Gebauer (1995b)
H205-006	Sutton Islets	Egmont	1993	10	10				Gebauer (1995b)
H205-007	Earles Cove	Earles Cove	1999	1	1	1	1		Gebauer (unpublished).
H205-008	Town-site	Gibsons Landing	1977	10	10				Forbes et al. (1985a)
H205-009	Twin creeks	Gibsons Landing	1980	2	2	2	2	2	Forbes et al. (1985a)
H205-009	Twin creeks	Gibsons Landing	1979	1	1		0		Forbes et al. (1985a)
H205-009	Twin creeks	Gibsons Landing	1978	54	54		0		Forbes et al. (1985a)
H205-010	Gunboat Bay	Pender Harbour	1981	30	0				Forbes et al. (1985a)
H205-010	Gunboat Bay	Pender Harbour	1980	0	0				Forbes et al. (1985a)
H205-010	Gunboat Bay	Pender Harbour	1979	94	44		18	54	Forbes et al. (1985a)
H205-010	Gunboat Bay	Pender Harbour	1978	93	43		19	40	Forbes et al. (1985a)
H205-010	Gunboat Bay	Pender Harbour	1977	75	75				Forbes et al. (1985a)
H205-010	Gunboat Bay	Pender Harbour	1963	75	75				Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H205-011	Tuwanek	Sechelt	1999	5	3	3	0		Vennesland (2000)
H207-001	Brackendale	Squamish	1993	5	0				Butler (1997)
H208-001	Pacific Spirit Park	Vancouver	1999	188	174	174	106	233	Vennesland (2000)
H208-001	Pacific Spirit Park	Vancouver	1998	190	190	190	70	102	Vennesland (2000)
H208-001	Pacific Spirit Park	Vancouver	1997	119	75	38	20	48	Moul (1998b)
H208-001	Pacific Spirit Park	Vancouver	1996	217	217				Butler (1997)
H208-001	Pacific Spirit Park	Vancouver	1994	169	169				Gebauer (1995a)
H208-001	Pacific Spirit Park	Vancouver	1993	162	162				Gebauer (1995a)
H208-001	Pacific Spirit Park	Vancouver	1992	142	142	49	39	100	Gebauer (1995a)
H208-001	Pacific Spirit Park	Vancouver	1990	157	140	20	17	48	
H208-001	Pacific Spirit Park	Vancouver	1989	141	141	12	10	22	
H208-001	Pacific Spirit Park	Vancouver	1988	158	158	17	14	36	Butler (1997)
H208-001	Pacific Spirit Park	Vancouver	1987	214	156	156	126	233	Butler (1997); Elliott et al. (1989)
H208-001	Pacific Spirit Park	Vancouver	1986	78	78	78	46	92	Elliott et al. (1989)
H208-001	Pacific Spirit Park	Vancouver	1981	150	125		42	81	Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1980	147	130		51	122	Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1979	130	130		22	64	Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1978	128	108		30	83	Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1977	92	82		23	50	Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1974	1	1				Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1973	1	1				Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1972	30	30				Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1971	75	75				Forbes et al. (1985a)
H208-001	Pacific Spirit Park	Vancouver	1970	127	120				Forbes et al. (1985a)
H208-002	Stanley Park Aquarium	Vancouver	1999	3	3	3	0		Vennesland (2000)
H208-002	Stanley Park Aquarium	Vancouver	1998	3	3		0		Vennesland (2000)
H208-002	Stanley Park Aquarium	Vancouver	1997	20	19	19	0		Moul (1998b)
H208-002	Stanley Park Aquarium	Vancouver	1995	19	19	19	19	49	Butler (1997)
H208-002	Stanley Park Aquarium	Vancouver	1994	17	16	16	16	38	Butler (1997)
H208-002	Stanley Park Aquarium	Vancouver	1993	30	30				Gebauer (1995a)
H208-002	Stanley Park Aquarium	Vancouver	1992	33	33	32	31	90	Gebauer (1995a)
H208-002	Stanley Park Aquarium	Vancouver	1991	19	19				Butler (1997)
H208-002	Stanley Park Aquarium	Vancouver	1990	30	30	15		38	Butler (1997)
H208-002	Stanley Park Aquarium	Vancouver	1989	30	30	20		38	Butler (1997)
H208-002	Stanley Park Aquarium	Vancouver	1987	31	31	16		56	Butler (1997)
H208-002	Stanley Park Aquarium	Vancouver	1981	29	20		9	20	Forbes et al. (1985a)
H208-002	Stanley Park Aquarium	Vancouver	1980	33	33		19	39	Forbes et al. (1985a)
H208-002	Stanley Park Aquarium	Vancouver	1979	40	38	38	38	91	Forbes et al. (1985a)
H208-002	Stanley Park Aquarium	Vancouver	1978	44	44		22	56	Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H208-002	Stanley Park Aquarium	Vancouver	1977	31	19		12	28	Forbes et al. (1985a)
H208-003	Cliff Street	Burnaby	1999	50	50				Vennesland (2000)
H208-003	Cliff Street	Burnaby	1998	50	50	50	48	141	Vennesland (2000)
H208-003	Cliff Street	Burnaby	1997	20	20				Moul (1998b)
H208-003	Cliff Street	Burnaby	1994	20	20				Gebauer (1995a)
H208-003	Cliff Street	Burnaby	1993	20	20				Gebauer (1995a)
H208-003	Cliff Street	Burnaby	1992	20	20				Gebauer (1995a)
H208-004	Admiralty Point	Port Moody	1994	10	10				Gebauer (1995a)
H208-005	Mary Hill	Port Coquitlam	1999	107	107	17	17	38	Vennesland (2000)
H208-005	Mary Hill	Port Coquitlam	1998	108	108	45	35	84	Vennesland (2000)
H208-005	Mary Hill	Port Coquitlam	1997	62	62	62	0		Moul (1998b)
H208-005	Mary Hill	Port Coquitlam	1994	52	52				Gebauer (1995a)
H208-005	Mary Hill	Port Coquitlam	1993	22	22				Gebauer (1995a)
H208-005	Mary Hill	Port Coquitlam	1992	16	16	11	11	16	Gebauer (1995a)
H208-006	McIvor Road	Maple Ridge	1997	0	0				Moul (1998b)
H208-006	McIvor Road	Maple Ridge	1994	43	43				Gebauer (1995a)
H208-006	McIvor Road	Maple Ridge	1993	30	30				Gebauer (1995a)
H208-006	McIvor Road	Maple Ridge	1992	10	10				Gebauer (1995a)
H208-006	McIvor Road	Maple Ridge	1979	8	5		5	15	Butler (1997)
H208-006	McIvor Road	Maple Ridge	1978	10	8		6	13	Butler (1997)
H208-006	McIvor Road	Maple Ridge	1977	10	10		8	15	Butler (1997)
H208-007	North Alouette River	Pitt Meadows	1997	0	0				Moul (1998b)
H208-007	North Alouette River	Pitt Meadows	1994		0				Gebauer (1995a)
H208-007	North Alouette River	Pitt Meadows	1993		0				Gebauer (1995a)
H208-007	North Alouette River	Pitt Meadows	1992	65	0				Gebauer (1995a)
H208-007	North Alouette River	Pitt Meadows	1991	70	70				Gebauer (1995a)
H208-007	North Alouette River	Pitt Meadows	1974	10	10				Butler (1997)
H208-008	Rennie Road	Pitt Meadows	1997	0	0				Moul (1998b)
H208-008	Rennie Road	Pitt Meadows	1993	6	4	4	0		Gebauer (1995a)
H208-008	Rennie Road	Pitt Meadows	1992	6	0				Butler (1997)
H208-009	McCormick Marsh	Matsqui	1997	0	0				Moul (1998b)
H208-009	McCormick Marsh	Matsqui	1993	0	0				Gebauer (1995a)
H208-009	McCormick Marsh	Matsqui	1992	12	0				Gebauer (1995a)
H208-009	McCormick Marsh	Matsqui	1989	40	40				Phil Whitehead CWS
H208-010	Crescent Island	Matsqui	1997	0	0				Moul (1998b)
H208-010	Crescent Island	Matsqui	1992	0	0				Gebauer (1995a)
H208-010	Crescent Island	Matsqui	1991	6	0				Butler (1997)
H208-010	Crescent Island	Matsqui	1990	8	0	6	0		Gebauer (1995a)
H208-010	Crescent Island	Matsqui	1974	1	1				Forbes et al. (1985a)
H208-010	Crescent Island	Matsqui	1963	1	1				Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H208-010	Crescent Island	Matsqui	1962	3	3				Forbes et al. (1985a)
H208-010	Crescent Island	Matsqui	1960	0	0				Butler (1997)
H208-011	De Boville Slough 1	Coquitlam	1997	0	0				Moul (1998b)
H208-011	De Boville Slough 1	Coquitlam	1994	0	0				Gebauer (1995a)
H208-011	De Boville Slough 1	Coquitlam	1993	34	34	34	0		Butler (1997)
H208-011	De Boville Slough 1	Coquitlam	1992	70	70	59	0		Gebauer (1995a)
H208-012	De Boville Slough 2	Coquitlam	1997	0	0				Moul (1998b)
H208-012	De Boville Slough 2	Coquitlam	1994	34	0				Butler (1997)
H208-012	De Boville Slough 2	Coquitlam	1993	34	34	34	0		Gebauer (1995a)
H208-012	De Boville Slough 2	Coquitlam	1992	50	50	50	38	72	Gebauer (1995a)
H208-013	Colony Farm	Port Coquitlam	1997	0	0				Moul (1998b)
H208-013	Colony Farm	Port Coquitlam	1994	1	0				Gebauer (1995a)
H208-013	Colony Farm	Port Coquitlam	1993	1	1	1	0		Gebauer (1995a)
H208-013	Colony Farm	Port Coquitlam	1992	4	4	4	2	8	Gebauer (1995a)
H208-013	Colony Farm	Port Coquitlam	1978	162	162		43	99	Butler (1997)
H208-013	Colony Farm	Port Coquitlam	1977	169	169		42	97	Butler (1997)
H208-013	Colony Farm	Port Coquitlam	1973	59	48				Butler (1997)
H208-014	Clayburn	Matsquit	1997	0	0				Moul (1998b)
H208-014	Clayburn	Matsquit	1995		0				Gebauer (1995a)
H208-014	Clayburn	Matsquit	1994		0				Butler (1997)
H208-014	Clayburn	Matsquit	1993	7	2	2	0		Gebauer (1995a)
H208-015	Alouette River	Maple Ridge	1999	120	120	64	49	79	Vennesland (2000)
H208-015	Alouette River	Maple Ridge	1998	86	86	66	66	171	Vennesland (2000)
H208-015	Alouette River	Maple Ridge	1997	63	63				Moul (1998b)
H208-016	Mission - Silvermere	Mission	1999	45	39	36	27	51	Vennesland (2000)
H208-016	Mission - Silvermere	Mission	1998	60	60	60	56	119	Vennesland (2000)
H208-016	Mission - Silvermere	Mission	1997	10	10				Moul (1998b)
H208-017	Hatzic Lake	Mission	1999	67	67	56	47	112	Vennesland (2000)
H208-017	Hatzic Lake	Mission	1998	65	65	45	45	117	Vennesland (2000)
H208-018	Horseshoe Bay	West Vancouver	1999	2	2	2	2	8	Vennesland (2000)
H208-020	Rippington Road	Pitt Meadows	1981	8	6		4	10	Forbes et al. (1985a)
H208-020	Rippington Road	Pitt Meadows	1980	6	4		4	13	Forbes et al. (1985a)
H208-020	Rippington Road	Pitt Meadows	1979	1	1				Forbes et al. (1985a)
H208-021	Port Coquitlam IR 2	Port Coquitlam	1980	26	26	26	26	55	Forbes et al. (1985a)
H208-021	Port Coquitlam IR 2	Port Coquitlam	1979	34	31		17	30	Forbes et al. (1985a)
H208-021	Port Coquitlam IR 2	Port Coquitlam	1978	162	162		43	99	Forbes et al. (1985a)
H208-021	Port Coquitlam IR 2	Port Coquitlam	1977	169	169		42	98	Forbes et al. (1985a)
H208-021	Port Coquitlam IR 2	Port Coquitlam	1973	59	48				Forbes et al. (1985a)
H208-022	Widgeon Creek	Pitt Meadows	1979	2	2				Forbes et al. (1985a)
H208-023	UBC - Marine Drive	UBC	1973	1	1				Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H208-023	UBC - Marine Drive	UBC	1972	30	30				Forbes et al. (1985a)
H208-023	UBC - Marine Drive	UBC	1971	67	67	67	67	174	Forbes et al. (1985a)
H208-023	UBC - Marine Drive	UBC	1970	130	130				Forbes et al. (1985a)
H208-024	Lion's Bay	Lion's Bay	1980	4	4				Forbes et al. (1985a)
H208-025	Alice Lake	Squamish	1993	1	1				Butler (1997)
H208-026	UBC Research Forest	Pitt Meadows	1980	13	10				Butler (1997)
H208-026	UBC Research Forest	Pitt Meadows	1979	10	10				Butler (1997)
H208-026	UBC Research Forest	Pitt Meadows	1978	10	10				Butler (1997)
H208-026	UBC Research Forest	Pitt Meadows	1977	10	10				Butler (1997)
H208-026	UBC Research Forest	Pitt Meadows	1975	10	10				Butler (1997)
H208-026	UBC Research Forest	Pitt Meadows	1974	10	10				Butler (1997)
H208-028	Ruskin	Maple Ridge	1964	35	35				Butler (1997)
H208-028	Ruskin	Maple Ridge	1963	30	30				Butler (1997)
H208-028	Ruskin	Maple Ridge	1925	1	1				Butler (1997)
H208-029	Burnaby Lake	Burnaby	1942	1	1				Forbes et al. (1985a)
H208-029	Burnaby Lake	Burnaby	1933	1	1				Forbes et al. (1985a)
H208-030	Burnaby Mountain	Burnaby	1996	20	20				Butler (1997)
H208-030	Burnaby Mountain	Burnaby	1992	20	20				Butler (1997)
H208-031	Nature Park	Port Coquitlam	1973		0				Forbes et al. (1985a)
H208-031	Nature Park	Port Coquitlam	1971	76	68	68	68	190	Forbes et al. (1985a)
H208-032	Dewdney 2	Maple Ridge	1971	0	0				Forbes et al. (1985a)
H208-032	Dewdney 2	Maple Ridge	1970	30	30				Forbes et al. (1985a)
H208-032	Dewdney 2	Maple Ridge	1963	20	20				Forbes et al. (1985a)
H208-033	Dewdney 3	Maple Ridge	1974	0	0				Forbes et al. (1985a)
H208-033	Dewdney 3	Maple Ridge	1973	9	9				Forbes et al. (1985a)
H208-034	Dewdney 1	Maple Ridge	1974	0	0				Forbes et al. (1985a)
H208-034	Dewdney 1	Maple Ridge	1973	9	9				Forbes et al. (1985a)
H208-034	Dewdney 1	Maple Ridge	1972	11	11				Forbes et al. (1985a)
H208-035	North Vancouver	N. Vancouver	1929	1	1				Forbes et al. (1985a)
H208-035	North Vancouver	N. Vancouver	1923	18	18				Forbes et al. (1985a)
H208-036	Crane Ponds	Pitt Meadows	1981	5	0				Butler (1997)
H208-036	Crane Ponds	Pitt Meadows	1980	1	0				Butler (1997)
H208-036	Crane Ponds	Pitt Meadows	1979	1	1	1	1	1	Butler (1997)
H208-037	Stanely Park - Beaver L	Vancouver	1977	31	19		12	28	Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1974	21	21				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1971	30	30				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1970	40	40				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1969	25	25				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1968	25	25				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1967	40	40				Forbes et al. (1985a)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H208-037	Stanely Park - Beaver L	Vancouver	1966	28	28				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1961	25	25				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1959	25	25				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1928	27	27				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1923	23	23				Forbes et al. (1985a)
H208-037	Stanely Park - Beaver L	Vancouver	1921	37	37				Forbes et al. (1985a)
H208-038	Fraser Mills	Maillardville	1960	45	38				Forbes et al. (1985a)
H212-001	Scuttle Bay	Powell River	1997	0	0				Moul (1998b)
H212-001	Scuttle Bay	Powell River	1994	20	20				Moul (1994)
H212-002	Gibsons Beach	Powell River	1999	0	0				Vennesland (2000)
H212-002	Gibsons Beach	Powell River	1997	0	0				Moul (1998b)
H212-002	Gibsons Beach	Powell River	1992	0	0				Moul (1992)
H212-002	Gibsons Beach	Powell River	1991	13	13	13	0		Moul (1991)
H212-002	Gibsons Beach	Powell River	1990	38	35	33	22	51	Breault (1990)
H212-003	Willingdon Beach	Powell River	1999	0	0				Vennesland (2000)
H212-003	Willingdon Beach	Powell River	1997	0	0				Moul (1998b)
H212-003	Willingdon Beach	Powell River	1994	6	5				Gebauer (1995b)
H212-003	Willingdon Beach	Powell River	1993	10	10	10	0		Gebauer (1995b)
H212-003	Willingdon Beach	Powell River	1980	29	19				Forbes et al. (1985a)
H212-003	Willingdon Beach	Powell River	1978	6					Forbes et al. (1985a)
H212-003	Willingdon Beach	Powell River	1974		14				Forbes et al. (1985a)
H212-003	Willingdon Beach	Powell River	1973	30					Forbes et al. (1985a)
H212-004	Hazelton Street	Powell River	1999	0	0				Vennesland (2000)
H212-004	Hazelton Street	Powell River	1997	0	0				Moul (1998b)
H212-004	Hazelton Street	Powell River	1994	8	7				Moul (1994)
H212-004	Hazelton Street	Powell River	1993	7	7	7	4	6	Moul (1993)
H212-005	Penticton Street	Powell River	1999	0	0				Vennesland (2000)
H212-005	Penticton Street	Powell River	1997		0				Moul (1998b)
H212-005	Penticton Street	Powell River	1992		0				Moul (1992)
H212-005	Penticton Street	Powell River	1991		0				Moul (1991)
H212-005	Penticton Street	Powell River	1989	4	4	4	0		Breault (1989)
H212-005	Penticton Street	Powell River	1988	42	42	42	0		Breault (1988)
H212-006	Myrtle Beach	Powell River	1999	0	0				Vennesland (2000)
H212-006	Myrtle Beach	Powell River	1997	0	0				Moul (1998b)
H212-006	Myrtle Beach	Powell River	1994	2	2				Gebauer (1995b)
H212-006	Myrtle Beach	Powell River	1993	6	6				Gebauer (1995)
H212-007	Okeover Inlet	Powell River	1999	0	0				Vennesland (2000)
H212-007	Okeover Inlet	Powell River	1997	0	0				Moul (1998b)
H216-001	Snug Cove A	Bowen Island	1999	1	1	1	0		Vennesland (2000)
H216-002	Snug Cove B	Bowen Island	1999	2	2	2	2	4	Vennesland (2000)

Appendix 2. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H216-003	Anvil Island	Anvil Island	1980	8	0				Forbes et al. (1985a)
H216-003	Anvil Island	Anvil Island	1974	1	1				Forbes et al. (1985a)
H216-003	Anvil Island	Anvil Island	1972	1	1				Forbes et al. (1985a)
H216-004	Nelson Island	Nelson Island	1980	1	0				Forbes et al. (1985a)
H216-004	Nelson Island	Nelson Island	1977	1	0				Butler (1997)
H218-001	Cheam Lake	Agassiz	1999	15	15				Vennesland (2000)
H218-001	Cheam Lake	Agassiz	1997	0	0				Moul (1998b)
H218-001	Cheam Lake	Agassiz	1994	10	10				Gebauer (1995a)
H218-001	Cheam Lake	Agassiz	1993	15	15				Gebauer (1995a)
H218-001	Cheam Lake	Agassiz	1992	13	13				Gebauer (1995a)
H219-001	Harrison River	Harrison Mills	1999	0	0				Vennesland (2000)
H219-001	Harrison River	Harrison Mills	1998	20	15	20	0		Vennesland (2000)
H219-001	Harrison River	Harrison Mills	1997	27	27	27	0		Moul (1998b)
H219-001	Harrison River	Harrison Mills	1994	40	40				Gebauer (1995a)
H219-001	Harrison River	Harrison Mills	1993	40	40				Gebauer (1995a)
H219-001	Harrison River	Harrison Mills	1992	63	63	63	19	36	Gebauer (1995a)
H219-002	Chehalis River	Harrison Mills	1979	84	0				Forbes et al. (1985a)
H219-002	Chehalis River	Harrison Mills	1960	1	1				Forbes et al. (1985a)
H219-002	Chehalis River	Harrison Mills	1959	1	1				Forbes et al. (1985a)
H219-002	Chehalis River	Harrison Mills	1958	1	1				Forbes et al. (1985a)
H219-002	Chehalis River	Harrison Mills	1957	1	1				Forbes et al. (1985a)

Appendix 3. Historical records of Great Blue Heron colonies on the North Coast and Queen Charlotte Islands, British Columbia, 1920 to 1997.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H612-001	Kunghit Island	South Moresby	1946	1	1				Forbes et al. (1985a)
H613-001	Massett	Graham Island	1920	1	1				Forbes et al. (1985a)
H613-002	Massett Inlet	Graham Island	1927	1	1				Forbes et al. (1985a)
H613-003	Yakoun River Estuary	Port Clements	1996	2	2				Cober, A. (pers. com.)
H613-004	Chinkundl Creek	Skidegate	1997	2	2				Hetherington, A. (pers. com.)
H613-005	Demon Creek	Graham Island	1997	3	3				Hetherington, A. (pers. com.)

Appendix 4. Historical records of Great Blue Heron colonies in interior regions of British Columbia, 1920 to 1999.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H318-001	Grant Ranch	Lower Nicola	1999	7					Shewchuk, K. (pers. com.)
H320-001	Nicola River	Merrit	1982	1	1				Forbes et al. (1985a)
H326-001	Chum Lake	S. Thompson River	1980	3	3				Forbes et al. (1985a)
H326-001	Chum Lake	S. Thompson River	1973	1	1				Forbes et al. (1985a)
H326-002	Chum Lake east	S. Thompson River	1980	1	1				Forbes et al. (1985a)
H338-001	Darfield	N. Thompson River	1980	11	9				Forbes et al. (1985a)
H404-001	Moyie Lake	Cranbrook	1983	15	11				Forbes et al. (1985a)
H404-001	Moyie Lake	Cranbrook	1982	11	11				Forbes et al. (1985a)
H404-001	Moyie Lake	Cranbrook	1981	11					Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1983	66	57				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1982	54	54				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1981	70	55				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1980	85	63				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1977	93	93				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1975	122	122				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1973	114	114				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1972	95	95				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1971	90	90				Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1968	80					Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1968	80	80		23	28	Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1966	77					Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1948	40					Forbes et al. (1985a)
H406-001	Duck Lake	Creston	1947	40					Forbes et al. (1985a)
H406-002	Goat River	Creston	1984	33	33				Forbes et al. (1985a)
H406-002	Goat River	Creston	1982	30	25				Forbes et al. (1985a)
H406-002	Goat River	Creston	1981	23					Forbes et al. (1985a)
H406-002	Goat River	Creston	1980	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1979	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1978	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1977	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1976	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1975	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1974	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1973	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1972	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1971	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1970	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1969	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1968	15	15				Forbes et al. (1985a)
H406-002	Goat River	Creston	1967	15	15				Forbes et al. (1985a)

Appendix 4. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H406-003	Saugum Lake	Kootenay	1999	12	12				Tipper, G. (pers. com.)
H408-001	Salmo River	Salmo	1983	4	4				Forbes et al. (1985a)
H409-001	Nancy Green Lake	Castlegar	1999	1	1				Antifeau, T. (pers. com.)
H416-001	Slocan City	Slocan	1980	5					Forbes et al. (1985a)
H416-001	Slocan City	Slocan	1979	1	1				Forbes et al. (1985a)
H416-001	Slocan City	Slocan	1978	1	1				Forbes et al. (1985a)
H416-001	Slocan City	Slocan	1977	1	1				Forbes et al. (1985a)
H416-001	Slocan City	Slocan	1976	1	1				Forbes et al. (1985a)
H416-001	Slocan City	Slocan	1975	1	1				Forbes et al. (1985a)
H416-002	Slocan Pool	Slocan	1980	7	5				Forbes et al. (1985a)
H416-002	Slocan Pool	Slocan	1979	1	1				Forbes et al. (1985a)
H416-002	Slocan Pool	Slocan	1978	1	1				Forbes et al. (1985a)
H416-002	Slocan Pool	Slocan	1977	1	1				Forbes et al. (1985a)
H420-001	Fort Steele	Kootenay River	1977	10					Forbes et al. (1985a)
H421-001	Saint Mary's River	Fort Steele	1982	30	25				Forbes et al. (1985a)
H421-001	Saint Mary's River	Fort Steele	1980	14	14				Forbes et al. (1985a)
H421-001	Saint Mary's River	Fort Steele	1976	1	1				Forbes et al. (1985a)
H422-001	Colvalli	Kootenay River	1970	13					Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1982	45	35				Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1981	40	35				Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1980	46					Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1979	33					Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1973	10					Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1963	25					Forbes et al. (1985a)
H425-001	Fairmont	Columbia Lake	1941	2	2				Forbes et al. (1985a)
H426-001	Wilmer Wildlife Area	Columbia River	1981		0				Forbes et al. (1985a)
H426-001	Wilmer Wildlife Area	Columbia River	1980	10	5				Forbes et al. (1985a)
H426-001	Wilmer Wildlife Area	Columbia River	1979	8					Forbes et al. (1985a)
H426-001	Wilmer Wildlife Area	Columbia River	1978	10	0				Forbes et al. (1985a)
H426-001	Wilmer Wildlife Area	Columbia River	1976	30					Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1981		0				Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1980		0				Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1979	6					Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1976	6	6				Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1973	12					Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1967	25	25				Forbes et al. (1985a)
H426-002	Windermere Lake	Windermere	1963	25					Mark (1974)
H430-001	Duncan-Lardeau	Kootenay Lake	1999	20					Herbison, B. (pers. com.)
H433-001	Upper Arrow Lake	Revelstoke	1982	12	12				Forbes et al. (1985a)
H433-001	Upper Arrow Lake	Revelstoke	1981	17					Forbes et al. (1985a)

Appendix 4. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H433-001	Upper Arrow Lake	Revelstoke	1978	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1982	4	4				Forbes et al. (1985a)
H434-001	Golden	Golden	1980	15	15				Forbes et al. (1985a)
H434-001	Golden	Golden	1969	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1968	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1967	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1966	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1965	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1964	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1963	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1962	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1961	1	1				Forbes et al. (1985a)
H434-001	Golden	Golden	1960	1	1				Forbes et al. (1985a)
H434-002	Parsons	Columbia River	1982	75	60		14	35	Forbes et al. (1985a)
H434-002	Parsons	Columbia River	1981	65					Forbes et al. (1985a)
H434-002	Parsons	Columbia River	1980	10	10				Forbes et al. (1985a)
H434-002	Parsons	Columbia River	1968	1	1				Forbes et al. (1985a)
H435-001	Brisco - north	Columbia River	1982	54	40		18	47	Forbes et al. (1985a)
H435-001	Brisco - north	Columbia River	1981	34					Forbes et al. (1985a)
H435-001	Brisco - north	Columbia River	1980	40					Forbes et al. (1985a)
H435-001	Brisco - north	Columbia River	1979	28					Forbes et al. (1985a)
H435-001	Brisco - north	Columbia River	1978	49					Forbes et al. (1985a)
H435-001	Brisco - north	Columbia River	1974	51					Forbes et al. (1985a)
H435-002	Brisco - south	Columbia River	1981		0				Forbes et al. (1985a)
H435-002	Brisco - south	Columbia River	1980		0				Forbes et al. (1985a)
H435-002	Brisco - south	Columbia River	1979	1	1				Forbes et al. (1985a)
H435-002	Brisco - south	Columbia River	1978	15					Forbes et al. (1985a)
H501-001	Little Horse Lake	100 Mile House	1999	30	30				Packham, R. (pers.com.)
H501-001	Little Horse Lake	100 Mile House	1998	30	30				Packham, R. (pers.com.)
H501-001	Little Horse Lake	100 Mile House	1997	30	30				Packham, R. (pers.com.)
H501-001	Little Horse Lake	100 Mile House	1996	30	30				Packham, R. (pers.com.)
H501-002	Muddy Lake	100 Mile House	1999		0				Steciw, J. (pers. com.)
H501-002	Muddy Lake	100 Mile House	1998	30	30				Packham, R. (pers.com.)
H501-002	Muddy Lake	100 Mile House	1997	30	30				Packham, R. (pers.com.)
H501-002	Muddy Lake	100 Mile House	1996	30	30				Steciw, J. (pers. com.)
H501-002	Muddy Lake	100 Mile House	1995	25	25				Steciw, J. (pers. com.)
H502-001	Fox Mt. Beacon	Williams Lake	1998	1	1				Steciw, J. (pers. com.)
H502-001	Fox Mt. Beacon	Williams Lake	1994	1	1		1	4	Steciw, J. (pers. com.)
H502-002	Big L. - Swanson Rd	Williams Lake	1999	4	4				Steciw, J. (pers. com.)
H502-002	Big L. - Swanson Rd	Williams Lake	1998	4	4				Steciw, J. (pers. com.)

Appendix 4. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H502-002	Big L. - Swanson Rd	Williams Lake	1997		0				Steciw, J. (pers. com.)
H502-002	Big L. - Swanson Rd	Williams Lake	1996		0				Steciw, J. (pers. com.)
H502-002	Big L. - Swanson Rd	Williams Lake	1995	1	1				Steciw, J. (pers. com.)
H502-002	Big L. - Swanson Rd	Williams Lake	1994	1	1				Steciw, J. (pers. com.)
H502-002	Big L. - Swanson Rd	Williams Lake	1993	1	1				Steciw, J. (pers. com.)
H502-003	Exeter Lake	100 Mile House	1999		0				Steciw, J. (pers. com.)
H502-003	Exeter Lake	100 Mile House	1998	30	30				Steciw, J. (pers. com.)
H502-003	Exeter Lake	100 Mile House	1997	30	30				Steciw, J. (pers. com.)
H502-003	Exeter Lake	100 Mile House	1996	30	30				Steciw, J. (pers. com.)
H502-004	Hawks Creek	Williams Lake	1999	0	0				Steciw, J. (pers. com.)
H502-004	Hawks Creek	Williams Lake	1998	7	7				Steciw, J. (pers. com.)
H502-004	Hawks Creek	Williams Lake	1997	7	7				Steciw, J. (pers. com.)
H502-004	Hawks Creek	Williams Lake	1996	1	1				Steciw, J. (pers. com.)
H502-004	Hawks Creek	Williams Lake	1990	4					Steciw, J. (pers. com.)
H502-005	Big Lake FSR	Williams Lake	1999	0	0				Steciw, J. (pers. com.)
H502-005	Big Lake FSR	Williams Lake	1998	12	12				Steciw, J. (pers. com.)
H502-005	Big Lake FSR	Williams Lake	1997	1	1				Steciw, J. (pers. com.)
H502-006	Chimney Lake	Williams Lake	1999	3	3				Steciw, J. (pers. com.)
H801-001	Vaseux Lake	Vaseux Lake	1983	5					Forbes et al. (1985a)
H801-002	Hatfield's Island	Vaseux Lake	1988	1	1				Dyer, O. (pers. com.)
H801-002	Hatfield's Island	Vaseux Lake	1986	2	1				Cannings et al. (1987)
H801-002	Hatfield's Island	Vaseux Lake	1985	1	1				Cannings et al. (1987)
H808-001	Chain Lakes	Summerland	1972	1	1				Cannings et al. (1987)
H809-001	Island Road	Oliver	1992	3					Dyer, O. (pers. com.)
H810-001	Kelowna Airport	Kelowna	1999	6	6				Gyug, L. (pers. com.)
H810-002	Mission Creek	Kelowna	1999	5					Ether, T. (pers. com.)
H810-002	Mission Creek	Kelowna	1986	3	3				Cannings et al. (1987)
H810-002	Mission Creek	Kelowna	1985	3	3				Cannings et al. (1987)
H810-002	Mission Creek	Kelowna	1984	3	3				Cannings et al. (1987)
H810-002	Mission Creek	Kelowna	1983	3	3				Cannings et al. (1987)
H810-002	Mission Creek	Kelowna	1982	3	3				Cannings et al. (1987)
H810-002	Mission Creek	Kelowna	1981	3	3				Cannings et al. (1987)
H814-001	Jewel Lake	Greenwood	1992	3					Dyer, O. (pers. com.)
H822-001	Swan Lake	Vernon	1981	1	1				Forbes et al. (1985a)
H822-002	Coldstream Creek	Vernon	1986	1	1				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1999	35	35				Siddle, C. (pers. com.)
H822-003	Vernon city	Vernon	1998	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1997	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1996	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1995	7	7				Cannings et al. (1987)

Appendix 4. Continued.

Colony ID code	Colony name	Locality	Year	Total nests	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
H822-003	Vernon city	Vernon	1994	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1993	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1992	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1991	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1990	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1989	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1988	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1987	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1986	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1985	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1984	7	7				Cannings et al. (1987)
H822-003	Vernon city	Vernon	1983	7	7				Cannings et al. (1987)
H823-001	Duteau Creek	Vernon	1983	6	6				Cannings et al. (1987)
H826-001	Gardom Lake	Armstrong	1946	2					Forbes et al. (1985a)
H826-001	Gardom Lake	Armstrong	1945	2					Forbes et al. (1985a)
H826-002	Shuswap River	Enderby	1994	20					Dyer, O. (pers. com.)
H826-002	Shuswap River	Enderby	1980	20					Forbes et al. (1985a)
H826-002	Shuswap River	Enderby	1979	7					Forbes et al. (1985a)
H826-002	Shuswap River	Enderby	1978	7					Forbes et al. (1985a)
H826-003	Otter Lake	Armstrong	1980	26	23				Forbes et al. (1985a)
H826-003	Otter Lake	Armstrong	1979	20					Forbes et al. (1985a)
H826-003	Otter Lake	Armstrong	1977	25					Forbes et al. (1985a)
H826-003	Otter Lake	Armstrong	1972	25	25				Cannings et al. (1987)
H826-003	Otter Lake	Armstrong	1963	24					Forbes et al. (1985a)
H826-003	Otter Lake	Armstrong	1962	12					Forbes et al. (1985a)

Appendix 5. Individuals providing information on Great Blue Heron status and occurrence in British Columbia.

Contact Name	Affiliation	Phone #	Email	Colony or Location
Adama, Doug	BC Hydro		doug.adama@bchydro.bc.ca	Kootenay
Antifeau, Ted	MELP, Nelson		tantifeau@nelson.env.gov.bc.ca	Kootenay
Baudin, Phil	Wild Bird Trust	604-922-7042	pbaudin@gddc.com	Vancouver Island and lower Fraser River Valley
Bowling, Jack	Prince George Naturalist Club		jbowling@direct.ca	Prince George
Butler, Rob	CWS, Delta	604-940-4672	rob.butler@ec.gc.ca	Vancouver Island and lower Fraser River valley
Cannings, Dick	Naturalist	250-496-4049	cannings@vip.net	South Okanagan
Caskey, Marlene	MELP	250 751-3220		Nanaimo
Chutter, Myke	MELP, Victoria	250-387-9797	myke.chutter@gems7.gov.bc.ca	General
Clow, Stewart			stewart.clow@gems2.gov.bc.ca	Castlegar
Dyer, Orville	MELP, Penticton	250-492-8200	ondyer@penticton.env.gov.bc.ca	South Okanagan
Ethier, Tom	MELP, Penticton	250-492-8200	tethier@penticton.env.gov.bc.ca	South Okanagan
Fergusen, Robert	Matrix Resource Services	250-348-2475	matrix@rockies.net	Columbia River valley
Gyug, Les	Okanagan Wildlife Consulting		les_gyug@bc.sympatico.ca	Central Okanagan
Herbinson, Brenda				
Hetherington, Anne	MELP	250-	anne.hetherington@gems8.gov.bc.ca	
Kellerhals, Rolf	Naturalist	250 285-3570		Quadra Island
Henigman, Maggie	MELP	250 751-3214		Nanaimo
Jamieson, Bob		250-422-3322	bjamieson@cintek.com	Kootenay
Morrison, Karen	MELP, Nanaimo	250 751-3216	kmorrison@nanaimo.gov.env.bc.ca	Nanaimo
Packham, Roger	MELP, Williams Lake		rmpackha@williams.env.gov.bc.ca	Cariboo/Chilcotin
Raginsky, Nina	Waterbird Watch Collective			McFadden Creek, Saltspring Island
Rice, Louise	Kamloops Naturalist Club		drice@mail.ocis.net	Kamloops
Siddle, Chris	N. Okanagan Naturalists' Club	250-542-1034	chris_siddle@mindlink.bc.ca	Vernon
Shewchuk, Katherine			kshewchu@nicolavalley.com	Nicola Valley
Steciw, Julie	MELP, Williams Lake		jsteciw@williams.env.gov.bc.ca	Cariboo/Chilcotin
Tipper, Gary	MELP, Cranbrook	250-489-8553	gtipper@cranbrook.env.gov.bc.ca	Cranbrook
Vennesland, Ross	SFU student		rgv@sfu.ca	Vancouver Island and lower Fraser River valley
Zimmerman, Ellen	East Kootenay Environmental Society	250-344-2000	ellenzim@rockies.net	Upper Columbia Valley

Wildlife Working Reports may be cited, but the preliminary nature of the data they contain should be noted. Working Reports 1-39 (and certain others) are presently out of print, but photocopies may be available through the Wildlife Branch, Ministry of Environment, Lands and Parks or other agencies. Titles of Working Reports 1-39 are available on request.

WR-40 Wolf-prey dynamics. Proceedings of a symposium sponsored by B.C. Ministry of Environment, Wildlife Branch, Faculty of Forestry, University of British Columbia and the Northwest Wildlife Preservation Society. February 1989. 188pp.

WR-41 Caribou research and management in B.C.: proceedings of a workshop. R. Page, ed. November 1988. 275pp. (Also printed as WHR-27)

WR-42 Trapping in British Columbia - a survey. R. Reid. January 1989. 55pp.

WR-43 Biophysical habitat units of the Lower Halfway study area: expanded legend. E.C. Lea and L.E.H. Lacelle. December 1989. 33pp.

WR-44 Long range habitat planning: proceedings. M. Fenger and V. Stevens, eds. March 1990. 49pp.

WR-45 Biophysical habitat units of the Mosley Creek study area: expanded legend and interpretations. E.C. Lea and R.C. Kowall. March 1990. 33pp.

WR-46 Habitat Management Section. Annual General Meeting. Yellowpoint Lodge - 1989 April 25-27. Wildlife and Recreational Fisheries Branches, Ministry of Environment. July 1990. 107pp.

WR-47 Working plan — Khutzeymateen Valley grizzly bear study. A.N. Hamilton and J.A. Nagy. September 1990. 35pp. (Also printed as WHR-28).

WR-48 Khutzeymateen Valley grizzly bear study. Annual progress report - year 1 (1989/90), annual working plan - year 2 (1990/91). J.A. Nagy and A.G. MacHutchon. January 1991. 44pp. (Also printed as WHR-29).

WR-49 Fort Nelson and area average winter maximum snowpack mapping. R. Chilton. July 1990. 12pp.

WR-50 Marten habitat suitability research project - working plan. E.C. Lofroth and V. Banci. January 1991. 31pp.

WR-51 Khutzeymateen Valley grizzly bear study. Annual progress report - year 2 (1990/91), annual working plan - year 3 (1991/92). A.G. MacHutchon and S. Himmer. March 1992. 36pp. (Also printed as WHR-30)

WR-52 Abundance, Distribution and Conservation of Birds in the Vicinity of Boundary Bay, B.C. R.W. Butler, ed. 1992. 132pp. (Also printed as Technical Report Series No. 155, Pacific and Yukon Region, Can. Wildlife Service).

WR-53 Status of the Clouded Salamander in British Columbia. T.M. Davis and P.T. Gregory. March 1993. 19pp.

WR-54 Status of the Northern Pacific Rattlesnake in British Columbia. M.B. Charland, K.J. Nelson, P.T. Gregory. March 1993. 23pp.

WR-55 Status of the Shrew-mole in British Columbia. L. Kremsater, L. Andrusiak, F.L. Bunnell. March 1993. 26pp.

WR-56 Status of the Nuttall's Cottontail in British Columbia. D.W. Carter, A. Harestad, F.L. Bunnell. March 1993. 33pp.

WR-57 Status of the Sharp-tailed Snake in British Columbia. D.J. Spalding. March 1993. 15pp.

WR-58 Guidelines for Technical Publications of the Wildlife Program. E. Stanlake. March 1993. 57pp.

WR-59 Status of Keen's Long-eared Myotis in British Columbia. M. Firman, M. Getty, and R.M.B. Barclay. March 1993. 29pp.

WR-60 Biophysical Habitat Units for the Tatlayoko Lake Study Area: expanded legend and interpretations. E.C. Lea and R.C. Kowall. March 1993. 22pp.

WR-61 Status of the Pallid Bat in British Columbia. K. Chapman, K. McGuinness, R.M. Brigham. February 1994. 32pp.

WR-62 Status of the Bald Eagle in British Columbia. D.A. Blood and G. G. Anweiler. February 1994. 92pp

WR-63 A Survey of the Bat Fauna of the Dry Interior of British Columbia. S.L. Holroyd, R.M.R. Barclay, L.M. Merk, and R.M. Brigham. March 1994. 80pp.

WR-64 Distribution and Abundance of Four Species of Small Mammals At Risk in a Fragmented Landscape. G.A. Zuleta and C. Galindo-Leal. March 1994. 80pp.

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